Vol. XIV. — No. 5. May 1932.

BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

625. 235 & 625. 246]

Some interesting examples of weight saving in railway rolling stock

(more especially for heavy suburban service), by the use of light metals (1),

by Ad.-M. HUG, M.I.Mech.E., A.E.R.E.A., Consulting Engineer,
Thalwil-Zurich (Switzerland).

Summary. — As a beginning short mention of the value of weight saving, and of the use of light metals for the different classes of rolling stock from main line railways to tramways, and more particularly for suburban services and mountain railways, will be made. Comparative table of the results obtained in different countries.

Technical and economic data from applications carried out on suburban services in two great European Capitals, the question having been considered from all aspects, not only as regards the applications actually made, but also as to the possibilities of future extensions of such applications.

(1) See the Author's paper presented at the VIth International Mining, Metallurgical and Applied Geology Congress, Liége, 1930 (published in France in the *Revue Universelle des Transports*, Paris, No. 110).

Subdivision of the investigation into three Chapters :

Chapter I. — Different methods of traction on rails and the value of the use of light metals from an operating point of view. Comparison between different applications.

Chapter II. — The new motor units with light metal body on the Berlin suburban lines, 1931. Description of the stock and notes on the construction. Examples of the diagrams showing the limiting curves of the value of weight saving.

Chapter III. — A new type of trailer car for suburban service (Paris, French State Railways), 1930-1931.

I.

When considering the value of weight reduction of railway stock, it becomes

necessary to consider five different methods of traction, each of which has to be treated separately. These five cases are the following :

1. Main line services.

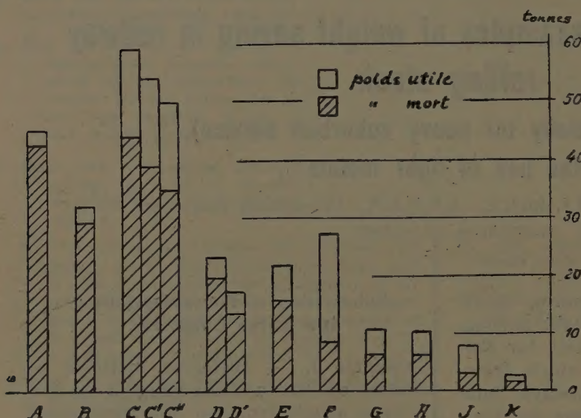
2. Heavy suburban services in large cities.

3. Light railways.

4. Mountain railways.

5. Tramways.

1. Obviously the cases 2 to 5 offer the greatest opportunity for weight reduction, for rolling stock for main line service it is also possible to show that there is some value in weight saving of stock, for example by an increase in the train loads the engines available can haul; in this way a reduction of 10 % in the weight of the vehicles makes it possible for the locomotives to haul 10 coaches instead of only 9. For stock having to



A. Eight-wheeled bogie coach for main lines.
B. Coach for ordinary trains.
C. Motor coach of the Berlin suburban lines, first steel construction.
C'. Same motor coach of light steel construction.
C''. Same motor coach but with body of aluminium alloys.
D. Motor coach of the Cleveland Railway (steel construction).
D'. Same vehicle built of light alloys.
E. Bogie brake van.
F. 20-ton four-wheeled goods wagon.
G. Tramway trailer coach entirely built of aluminium alloys.
H. Aluminium motorbus for town traffic.
J. 3-ton motor lorry.
K. Road motor car.

Fig. 1. — Comparative ratio of useful weight to dead weight (tare) for the various kinds of vehicles (rail and road).

Note : Poids utile = Profitable weight. — Poids mort = Dead weight.

run at high speeds over main lines it is sometimes considered that up to a certain point, heavy vehicles run better than light ones but the author's opinion is that good riding qualities and the necessary safety can be obtained by means of a suitable suspension. In addition, it must be remembered that for comfort the passengers must have plenty of room per seat, and this reduces still further the very low ratio of useful load to tare weight of stock. Figure 1 gives the ratio for different types of railway and tramway vehicles and, for comparative purposes, of motor lorries and road passenger vehicles. This shows, for example, that there is more value in saving the weight of passenger vehicles than in the case of goods wagons in view of the greater proportion of the tare weight.

Finally we must take into account the fact that on the main lines it is not usually necessary to have a high rate of acceleration at starting, because the fast trains

make few stops and the ordinary trains have in fact not a very high commercial speed. If we consider moreover the international services, the fact that the vehicles in the course of a single trip run through several countries evidently reduces the value of weight reduction : a railway which bears the greater cost of using the light metals naturally wishes to take the profit due to the saving of weight effected.

2. *For heavy suburban services of large cities*, the value of weight saving is very great; the trains must accelerate rapidly when starting and run at high speed over short sections; lighter carriages will reduce the costs of maintaining the track and make it possible to work the service more economically in particular through the lower tractive effort required. This case will be treated more completely in Chapters II and III hereafter.

Metropolitan railways should be included in this class as regards their rolling stock.

3. *Light railways* have undoubtedly great interest in the saving of weight of their rolling stock. As a rule these companies even more than the main line companies are obliged to look for small operating savings. Frequent stops and sharper curves than those on the main lines increase the value of any reduction of resistance to movement. The speed is generally lower, rarely reaching 40 to 50 km. (25 to 30 miles) an hour so that the use on a fairly large scale of light metals will have little influence as regards good riding.

4. In the case of *mountain railways* the value of weight reduction is obviously very great : we know that the gradient plays by far the most important part in the resistance to movement of a train. It will be of value to go into details here.

For the three cases considered above, the reduction of weight was only considered from the point of view of its influence on the cost of handling the vehicles whereas in the case of mountain railways the weight of the locomotives or motor vehicles must also be considered. We must differentiate here between on the one hand mountain railways working by adhesion alone, normally with gradients of up to 70 $^0/_{00}$ (1 in 14) (limit of adhesion gradient in severe climates and snow at high altitudes) and exceptionally as extreme limit, 110 $^0/_{00}$ (1 in 9), and on the other, *rack* and *funicular* (2) railways. In these, adhesion does not come into account and the reduction of weight can be considered from the point of view of economy alone, of course due regard being given to safe operation.

In the case of adhesion in mountain railways it must be kept in mind that there is a minimum adhesive weight which can be increased temporarily by artificial means; gear for cleaning the rails may be provided (such as the Bertschmann equipment shown in figure 2, or by a fitting which is called a « booster » working by electro-magnetic attraction similar to a rail brake slipper but which does not come into actual contact with the rail (3).

(2) For a recent and interesting example of the increase in the capacity of a telepheric line (air cable line) by weight saving, see the note by Mr. C. H. Waetjen, Consulting Engineer, in the *Bulletin de l'Association Patronale des Entreprises suisses de Transport*, No. 16, November 1931, page 197.

(3) See articles by the same author in the August 1931 number of this *Bulletin*, page 716, and in the *Revue de l'Aluminium*, Paris, No. 40, 1930, pages 1264-1265.

A case of great interest in which the tare weight of the motor stock was reduced by 5 % by the use of light alloys is that of the *Viège-Zermatt* line, in Switzerland, for the construction of the electric locomotives for combined adhesion and rack working, when this line was electrified in 1928-1929. This railway was built over 40 years ago and, in accordance with the technical practice of the period, the steepest gradients on the rack and on the adhesion section were fixed at 12.5 % and 2 % (1 in 8 and 1 in 50) respectively. In view of the high proportion of the weight of the locomotives, the adhesion conditions are very good on the relatively easy gradients and it was not necessary to retain any minimum adhesive weight. As on the other hand the maximum allowable weight of the new electric locomotives in service was only 48 t. (47.2 Engl. tons),

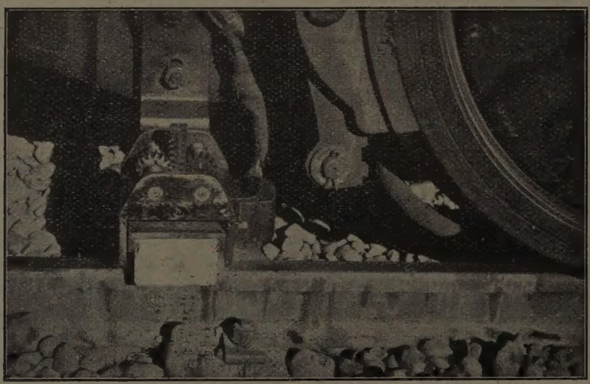


Fig. 2. — Apparatus for cleaning the rails and improving the coefffcient of adhesion.

that is to say a maximum allowable axle weight of 12 t. (11.8 Engl. tons) [the tare of the locomotive being 46.4 t. (45.7 Engl. tons)], provision had to be made for wide use of light alloys in their construction. The alloy used was the Swiss alloy known as « Anticorodal » which has very good mechanical and chemical characteristics and as a result the weight was reduced in the proportion of 1.65 tons of this material in place of 4 tons of steel.

In fact, the light metals were only used in the construction of the body of the locomotive but not on the main frame nor in the bogies and the electric equipment.

Figures 3 and 4 show respectively one of the five locomotives during construction and one of the bonnets made of anticorodal throughout.

Figure 5 shows locomotive No. 13 hauling a mixed goods and passenger train leaving Zermatt.

5. The case of *tramways* is much like case **3, light** railways. Weight saving

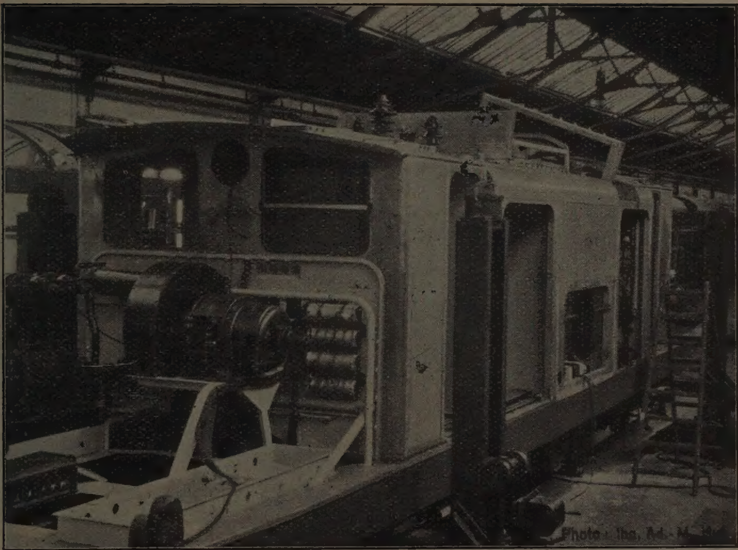


Fig. 3. — Electric locomotive of the Viège-Zermatt Railway (Switzerland). Erection of the body built of aluminium alloys.

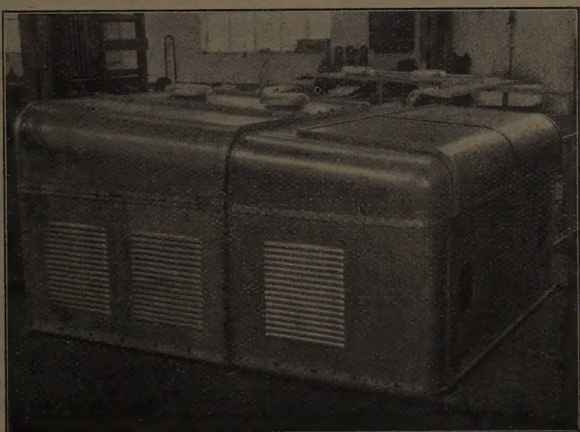


Photo : Eng. Ad.-M. HUG.

Fig. 4. — Anticorodal bonnet of locomotive shown in figure 3.

Fig. 5. — One of the Viège-Zermatt electric-locomotives starting from Zermatt (5 250 feet above sea level) in Winter time with a mixed goods and passenger train. — In the background, Mount Cervin (14 780 feet above sea level).

here has much importance and can be done on a large scale. Especially in the United States of America, as also in different European countries, very important applications have been made already with excellent results : to mention in particular the test vehicles of the Birmingham Corporation and the Naples Tramways [4]. Figure 6 shows the coupling used on the Naples vehicle, and figure 7 shows that the saving of current obtained with the new light Birmingham vehicle as compared with the usual type is about an average of 20 % per vehicle-kilometre.

In table I further on, the operating savings obtained in different countries by using light alloys are given. Comparison between the different results is made difficult through the basic differences in certain calculations, especially in the figures of consumption and price of current. In this table the figures given are based on the mean values of the current used, measured at the head line collector of the motor vehicles.

Some companies, however, based their figures and the price of the current on figures taken at meters placed at the outgoing side of the substations or at the incoming side. The losses of current between substation and current collector at the motor vehicle can be taken at about 8 %, but the determination of the cost of transforming and distributing the

(4) See *Bulletin de l'Association Patronale des Entreprises suisses de Transport*, Nos. 13-14, 1931, p. 170-171.

current largely depends upon personal judgment.

If the substations and contact lines are taken as part of the feeder system the cost of current should include interest and amortization charges increased by the costs of supervision and maintenance. This may increase the price by up to 40 % for the substation and up to 80 % for the contact line, interest on the capital invested included.

In preparing the table we have taken the same operating conditions in all the cases quoted without considering the factors which, excepting the saving of weight itself, can affect the current consumption; we have also taken the current consumption as being proportional to the tare weight of the vehicle. If it were desired to take into account in the calculations the various other factors, a coefficient of reduction should be applied to the figure shown for the current consumption per ton-kilometre, which coefficient should take into account the economy which might result from the reduction of weight and would vary between

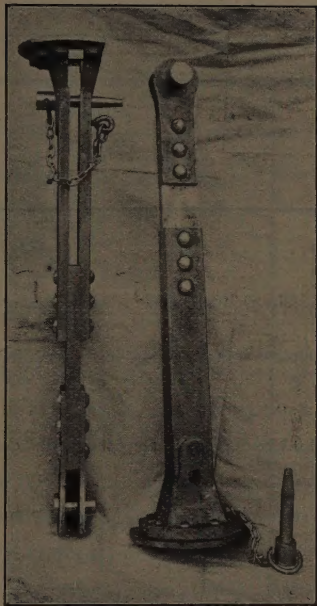


Fig. 6. — Duralumin coupling of light motor coach, Naples Tramways.

Fig. 7. — Comparison made at Birmingham (England) between the current consumption of a light coach (heavy line) and the average consumption of six standard coaches (fine line).

TABLE

Weight saving effected in different countries and

—	France.		
	State Railways.		Northern Railway.
Type of railway	Suburban.	Suburban.	Main lines (steam traction).
Type of vehicle (electric traction)	Motor unit (2 coaches)	Trailer *	Coach.
Current consumption at the bow, watt-hours per t.-km. (*per Engl. ton-mile*)	22 (36)	...	...
Price of current, 0.1 gold-franc per kw.-h.	2.0	...	...
Cost of current, 0.1 gold-franc per tkm. (*per English ton-mile*)	0.070 (0.114)	...	...
Kilometrage (*mileage*)	51 000 (31 600)	...	150 000 (93 210)
Weight of the standard motor unit, metric (*English*) tons	103.5 (101.8)	39.8 (39.16)	52.0 (51.16)
Weight of the light motor unit, metric (*English*) tons	— 98.8 (97.2)	— 37.6 (37.0)	— 47.2 (46.94)
Reduction of weight effected in metric (*English*) tons.	4.7 (4.6)	2 2 (2.16)	4.8 (4.72)
Percentage of weight saving	4.5	5.5	9
Light alloys used, metric (*English*) tons	2.9 (2.85)	1.5 (1.47)	2.9 (2.85)
Ratio c = light metal/weight reduction (see text)	0.62	0.68	0.60
Average price of light alloys, gold-francs per metric (*per English*) ton	...	...	4 250 (4 318)
Average price of steel, gold-francs per metric (*per English*) ton	...	...	250 (254)
Additional cost per metric (*per English*) ton of weight saving, gold-francs	2 500 (2 540)	...	2 200 (2 235)
Cost of current per metric (*per English*) ton and per year, gold-francs	250 (254)	...	...

* See Chapter III. — ** See Chapter II. — *** Weight saving partly due to

Note. — Certain of these figures are approximation,

0.7 and 0.9 according to the operating conditions. Other and secondary factors such as brake shoe wear, maintenance of spring gear and wheels and axles, etc., will be proportional to the mileage run.

In certain transportaton undertakings,

I.

corresponding costs of current consumption.

Switzerland.		Germany.	England.		U. S. A.
Zurich City Tramways.	Viège-Zermatt Railway.	German State Railway Company **	Average figures.	Birmingham Corporation.	Cleveland Railway.
Tramway.	Mixed (rack and adhesion).	Suburban.	Suburban.	Tramway.	Suburban.
Trailer.	Electric motor cars.	Motor unit (2 coaches).	Motor car.	Motor car.	Motor car.
...	93 (152)	46 (75.2)	63 (103)	76 (124.3)	...
1.6	0.9	0.8	0.75	...	...
0.270 (0.441)	0.135 (0.221)	0.054 (0.088)	0.075 (0.123)	...	...
42 000 (26 100)	40 000 (24 850)	100 000 (62 140)	80 000 (49 700)	...	59 000 (36 660)
6.5 (6 40)	48.8 (48.00)	61.6 (63.56)	17.3 (17.0)	16.8 (16.53)	19.3 (19.00)
— 5.4 (5 31)	— 46.4 (45.65)	— 58.1 (57.17)	— 11.7 (11.5)	— 13.6 (13.38)	— 13.5 (13.28)
1.1 (1.09)	2.4 (2.35)	6.5 (6.39)	5.6 (5.5)	3.2 (3.15)	5.8 (5.72)
*18 ****	*5*	*10*	*33*	*19*	*30*
...	1.6 (1.57)	5 (4.92) ****	4.4 (4.33)	....	3 (2.95)
...	0.67	0.77	0.78	...	0.52
...	4 500 (4 572)	4 500 (4 572)	3 750 (3 810)	...	...
...	300 (305)	300 (305)	325 (330)	...	...
...	2 500 (2 540)	3 025 (3 073)	2 375 (2 413)	...	2 325 (2 362)
725 (737)	350 (355)	350 (355)	400 (406)	...	550 (559)

the use of light metals. — **** See foot note (16) at the bottom of page 601.
exact figures often being difficult to obtain.

instead of taking into consideration the total price of the current when determining the value of the savings realised in electric traction by reduced consumption, only the part representing the net value of the saving in primary power is

taken into account. Obviously the costs of production and transmission of the current are the same whether the vehicle be of the light or heavy pattern.

The coefficient c of table I can be represented by the fraction :

$$c = \frac{\text{weight of light metal used}}{\text{saving of weight realised thereby}}.$$

If the light metal be used of the same dimensions as the steel parts replaced, this ratio would be :

$$c = \frac{\gamma_{Al}}{\gamma_{steel} - \gamma_{Al}} = \sim 0.55$$

in which

$\gamma_{Al} = 2.8$ = mean specific weight of aluminium alloys;

$\gamma_{steel} = 7.85$ = specific weight of steel.

At first sight it would appear impossible to attain this figure in view of the lower tensile strength of the light alloys as compared with steel, which naturally means rather heavier sections. We must remember, however, the fact that what may be called the indirect weight saving, that is to say the lightening of the frame and bogies made possible in consequence of the lighter superstructure may, by altering the form of construction, bring the value of c to 0.52 as in the case of the Cleveland light motor unit. Clearly the factor c will be subject to certain variations according to the type of operation (suburban service on main lines, town tramways, etc.) and it will be difficult to lay down any definite rule in this respect.

II.

The new light-metal motor coaches of the Berlin suburban railways, 1931 (5).

The German National Railway Company (the old German State Railways) ordered a few years ago, several light vehicles for test on the Berlin suburban lines (Berliner Stadt-, Ring- und- Vorortbahnen), in order to see how light metals behaved in service. The Company has admitted the benefits resulting from the lightening of the rolling stock more especially for a suburban system so widespread (see fig. 8) and with so uniform a stock. Four motor units each consisting of a motor coach and a trailer, *i. e.* the stock forming the complete standard train, were ordered half and half from the Wegmann Company, of Cassel and the Linke-Hofmann-Busch Company's Bautzen works. The first design (prepared in 1926) considered, involved the almost entire use of light metals. Before definitely placing, in 1927, the order for the four motor units (quarter trains as the Company calls them) the National Company thought it undesirable in the first trial to make such a wide application of aluminium on the heavy rolling stock used on railways. Up to that time, only a limited number of railway vehicles had been built in the United States of America on what was called the « all-aluminium » method and they had not been long enough in service then for a definite opinion to be formed on the result. It was decided that for

(5) See articles by Dr. G. Wagner, Chief Engineer of the German State Railway Company, in the review *Glaser's Annalen*, Berlin, entitled « Leichtmetall - Stadtbahnwagen », No. 1307 of 1931, and « Die neuen elektrischen Stadtbahnwagen unter Berücksichtigung ihrer Massenherstellung » in the Nos. 1250 and 1251 of 1929.

Fig. 8. — Plan of Berlin suburban system.

Note. — Heavy line = Electrification. — Fine line = Steam traction. — Black circles = Power supply stations. — Rectangle with diagonals = Main distribution station. — Rectangles = Substations. — Zschornewitz (about 68 miles from Berlin-Centre); Trattendorf (about 80 miles from Berlin-Centre).

the first four trial units the headstocks, the sole bars, the main frame cross bars carrying the bogie centre castings and the bogies as a whole were to be made of the usual light steel construction (6). This decision involved many important changes in the general design and this in conjunction with the lack of experience in machining light metals, resulted in considerable delays in the building. The first units were not finished until 1931, the first trial runs taking place in March (7) of the same year. Figure 9 shows the motor vehicles built by the Busch Works (see leading motor vehicle

(6) Before this decision was made the Wegmann Works had built a bogie entirely of light metal as suggested above, this bogie having been exhibited at Berlin (see fig. 11).

(7) The Author was present during some of these trial runs and was able to follow the construction of the vehicles at the works.

Fig. 9. — Double unit (half train) of light metal construction, on trial in the sidings of the Niederschöneweide (Berlin) shops of the German State Railway Company.

Fig. 10. — Electric motor coach, No. 5580, of light construction (aluminium alloys), built by the Wegmann Works, Cassel.

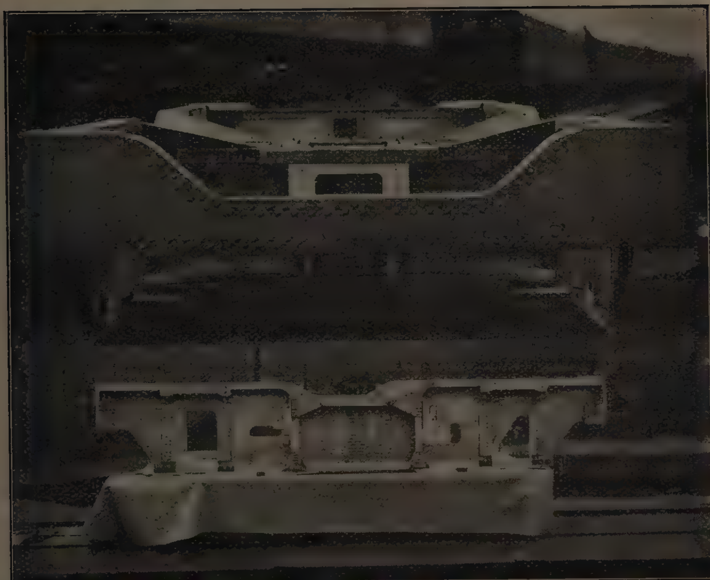


Fig. 11. — Front and side view of the trial bogie built of light alloys and shown at the Berlin Exhibition. — Weight: 750 kgr. (1 653 lb.).

No. 2589) on the test track of the Electric Rolling Stock Works at Niederschöneweide. Figure 10 shows motor vehicle No. 5580 built by the Wegmann Works (Class 1 BC 4es) which works with trailer coach No. 5581.

Technical description of the stock.

At each end of the unit consisting of a motor vehicle and its trailer, there is a driver's compartment. Figure 12 illustrates the standard unit used on the railway, the two vehicles of a unit being close coupled and the units as a whole being coupled to one another by standard automatic coupling of the « Scharfenberg » type. The bogies are exactly the same both under the motor vehicles and the trailers, the only difference being that the axles of the motor vehicles have gear wheels and carry nose-suspended motors. The layout of the body, except for the subdivision into second and third class, is absolutely the same; besides this, some of the trailers, normally used between units, have no driver's compartment. In this case, the two ends have the same seat arrangement (see figs. 13 and 14).

Table II below gives the number of seats and the principal dimensions of the standard motor vehicles.

Table III gives a comparison between the new light vehicles (column B) and the usual steel construction (column A),

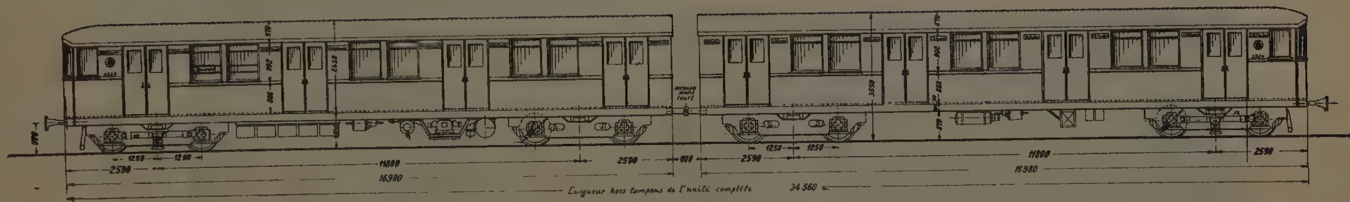


Fig. 12. — Elevation of a standard unit (quarter-train) of the Berlin suburban system (German State Railway Company).

Note. — Accouplement court = Short coupling. — Longueur hors. ... = Length of unit over buffers.

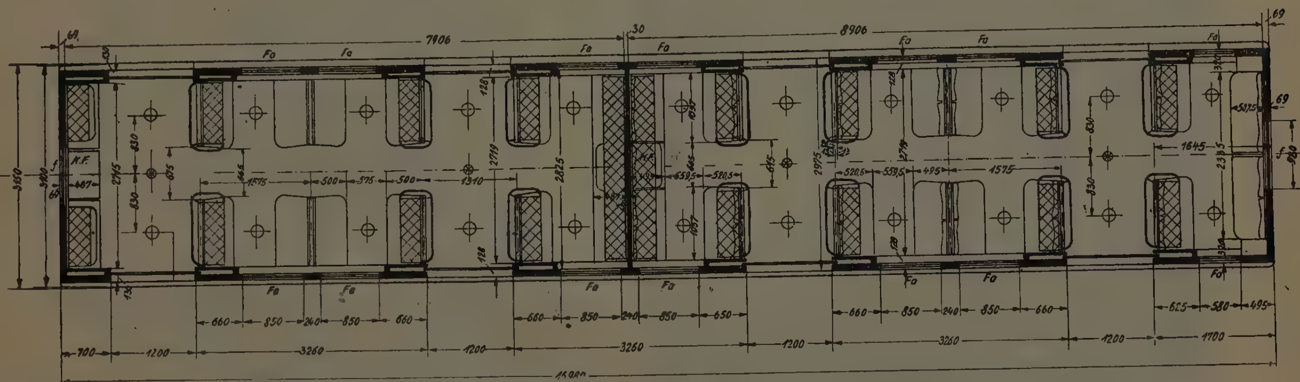


Fig. 13. — Plan view showing the seat arrangement of a trailer without driver's compartment (intermediate coach, compare with figures 20 and 21).

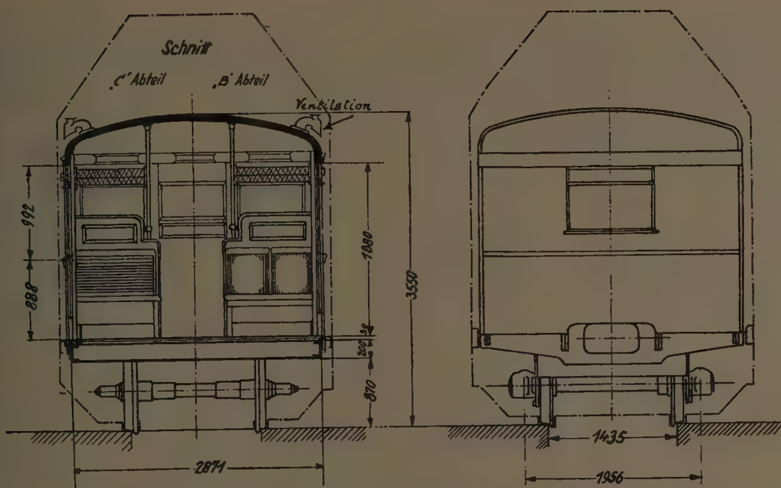


Fig. 14. — Cross section and front view of trailer, figures 13 and 21.

and also with the projected all-light-metal construction (column C). In this last heading, when deciding on the power of the motor, the fact that the masses to be accelerated were much reduced, was taken into account. For the actual light vehicles, lower powered motors and lighter equipment could not be considered as it would have been too costly to provide special equipment for only four trial units.

The saving of weight obtained per unit going from the original weight of 63.56 Engl. tons to 57.17 Engl. tons is 6.39 Engl. tons which is remarkable in view of the number of parts for which steel was used. This lightening represents 10 % on the gross weight of the standard unit; as only the body of the carriages was new, it is logic to compare the weight of the normal design of body and that of the light construction : in this way, the reduction is from 32.27 to 25.88 Engl. tons or a reduction of about 20 %.

The builders were rather hindered by the many restrictions laid down as regards the use of the light metals; none the less from the figures of the third column of table III, it will be seen that it is possible to lighten the body by 48 %, the bogies by 28 %, the electric gear by 18 %, and the unit as a whole by 37 %.

Such high percentages of weight saving obviously cannot be obtained by simply substituting aluminium for steel, but involves designing the structure on entirely new bases so as to get the most economical solutions as regards static stresses and by making the best use of the mechanical and physical properties of the aluminium alloys (8). Moreover it was necessary to take into account the influence of the weight saving on the

(8) See on this subject the Author's paper on articulated coaches, published in the August 1931 number of the *Bulletin of the Railway Congress*.

TABLE II.

Leading dimensions of the standard vehicles (steel).

Number of seats (per unit)	112
Standing places (per unit).	190
Total places (per unit).	302
Arrangement of doors :	4 sliding doors on the two sides of each vehicle (width of opening : 1 200 mm.)
Length over body	16 980 mm. (55 ft. 8 1/2 in.)
Between bogie centres	11 800 — (38 ft. 8 19/32 in.)
Bogie wheel base	2 500 — (8 ft. 2 7/16 in.)
Height of body.	2 450 — (8 ft. 15/32 in.)
Overall width	3 150 —. (10 ft. 4 1/2 in.)
Diameter of journals.	110 — (4 5/16 in.)
Diameter of the wheels	900 — (2 ft. 11 7/16 in.)
Length of the unit over buffers.	35.40 m. (116 ft. 1 3/4 in.)

TABLE III.

Comparison between the different methods of construction.

—	A All steel.	B Light vehicles built* (mixed construction).	C All aluminium.
Electric equipment	4 motors, 100 kw. power, hourly rating, 800 r. p. m.	4 motors, 100 kw. power, hourly rating, 800 r. p. m.	4 motors, 70 kw. power, hourly rating.
Gear ratio	1 : 4.25	1 : 4.25	—
Maximum speed, km. (*miles*) pr hour.	80 (*50*)	80 (*50*)	80 (*50*)
Air brake **	Knorr, single cylinder 14"; automatic adjustment according to load, after each stop.		
Weight per unit :			
Body without electric equipment, metric (*English*) tons.	32.8 (32.27)	26.3 (25.88)	17.0 (16.72)
Bogies without gearing, metric (*English*) tons	21.2 (20.86)	21.2 (20.86)	15.0 (14.76)
Electric equipment with motors and gears, metric (*English*) tons) . .	10.6 (10.43)	10.6 (10.43)	8.8 (8.66)
Total tare weight, metric (*English*) t.	64.6 (63.56)	58.1 (57.17)	40.8 (40.14)
Tare weight per place (passengers), kgr. (lb.)	*214* (**479**)	*193* (**432**)	*135* (**302**)

* Based on the units built by the Busch Works.
** See particulars on page 595.

static and dynamic forces of a train in service. Below the principles which were followed in getting out the designs are explained in detail.

Principles of design.

Materials and their properties.

In building the light vehicles the following alloys were used :

Aeron (Lautal) for the girders and the panels. The component parts are either rolled or forged and to increase their strength are heated to a temperature a little above 500° C. (932° F.) then quenched to bring them up to a tensile strength of 30 to 33 kgr./mm² (19 to 21 Engl. tons per sq. inch). These alloys however after heat treatment are deformable at a low temperature, but their strength can be increased by a long tempering at about 120 to 140° C. (248 to 284° F.). Thin sheets have a tensile strength of up to 42 kgr./mm² (26.7 Engl. tons per sq. inch) with an elongation of about 20 %.

The *Scleron* alloy, heat-treated similarly but without tempering to 120 to 140° C., has a tensile breaking strength of 44 to 50 kgr./mm² (28 to 31.7 Engl. tons per sq. inch) with from 8 to 15 % elongation. The *Scleron* alloy has been replaced in the construction of the most recent vehicles by a new alloy known as VLW.14.B having the same tensile strength as the *Scleron* but having a much higher elongation.

For castings the more ductile alloys *Alpax* (Silumin) and *Cetal*, are used. Table IV below gives details of the composition and characteristics of the different light alloys used.

The selection of the alloy to be used was difficult as at that time there was insufficient experience to know how large parts made of light alloys would behave under shock and vibration and especially in the event of collision; the satisfactory result of using these light metals in aeronautical construction was used as the basis. Since that period, experience has shown that in the application of those light alloys to railway rolling stock, there was no fear of harmful effects being caused by shocks nor by vibrations.

Plates with thicknesses of 2 to 6 mm. (5/64 to 1/4 inch) and even thicker, such as those for the different rolled Z bars, U- and angles, flats, rounds and tubes. The rivets and wood screws were also made of light metal but the bolts fastening the metal parts together were made of steel.

One of the principal differences between the light alloys was found to be the different way they behave in the Brinell test.

Although at the normal temperature of + 10° C. (50° F.) steel is 3 to 10 times stronger than the light alloys, this difference becomes negligible at a temperature of — 40° C. (— 40° F.).

The properties of the light alloys do not change at low temperatures, whereas that of steel is very unfavourably affected.

The lower resistance of the light metals to a blow has often been brought up against them, but we know that by comparison in winter at low temperatures, steel loses all its superiority in this respect.

The lower modulus of elasticity T of the light metals as compared with that of steel gives a greater capacity of resistance A to shock :

$$A = \frac{\sigma^2 \cdot V}{2T}$$

σ representing the stress at yield point, V the volume; the result is that in case

TABLE IV.

Composition and properties of various light alloys.

Composition.	Al %	Cu %	Zn %	Si %	Mn %	Li %	Specific weight.	Elastic limit, kgr./mm² (Engl. tons per sq. inch).	Tensile strength, kgr./mm² (Engl. tons per sq. inch).	Elongation %	Brinell hardness.
Lautal-Aeron	93.2	4.3	—	2	0.5	—	2.75	12-14 (7.6-8.9)	38-40 (24.1-25.4)	25-18	⩽ 120
Scleron	83.8	3	12	0.5	0.6	0.05-0.10	2.95	18-20 (11.4-12.7)	44-50 (27.9-31.7)	15-10	⩽ 120
Alpax (Silumin) (rolled or pressed).	87	—	—	13	—	—	2.65	4.5 (2.86) approx.	20-25 (12.7-15.9)	8-4	70-80
Cetal (cast)	80.5	3	10	6.5	—	—	2.6	5.5 (3.5)	22 (14.0) approx.	7 approx.	80

of collision the damage will be more localised independently of the fact that the masses, and consequently the shock effect, will be much lower.

In the calculations, the most important factor is the influence of « fatigue » by which is meant the limit up to which the stress can be repeated without causing any permanent deformation.

This limit may be taken at about 15 to 17 kgr./mm² (9.5-10.8 Engl. tons per sq. inch) for aeron and at 17 to 21 kgr. mm² (10.8 to 13.3 Engl. tons per sq. inch) for scleron as compared with about 46 kgr./mm² (29.2 Engl. tons) for steel.

Experience in service will show whether the values taken are correct. In a general way it may be said that the alloys of the aeron kind containing as they do a small proportion of manganese (like duralumin and avional which are copper alloys) can be used for parts which have to be cold worked whereas scleron (see table IV above) is better where no great deformation cold is required. To get maximum elongation scleron has been selected in the case under consideration and used everywhere where the metal has to be neither stamped nor pressed. Its lower hardness necessitates care in all parts subject to wear or in the case of large surfaces under high specific loading; it is desirable that such surfaces should be reinforced by plates of harder light metal or by sheet steel.

Safety question.

The object of the builder was to provide vehicles of the same degree of safety in service as that of the old steel vehicles in use whilst using as economically as possible the light alloys which for equal volume cost 7 to 10 times more than steel.

An economical construction is only to be got by careful calculation taking into account all possible loads and thereby taking the fatigue value of the metall as high as about 80 % of the figures given above. The 20 % remaining can be considered as the coefficient of safety needed

to make up for any differences due to possible irregularities in the composition of the alloys or joints.

In order that the hypotheses best corresponding to the actual condition may be clearer, let us state that the difficulty of so doing is much greater because the static system is complicated and the acting forces are not clearly known. This is the reason why the problem of building railway vehicles is a most complicated one, and depends largely on the personal judgment of the builder.

The sides of the vehicles are generally calculated as girders even though the envelope they form cannot transmit compression forces but only tensile ones.

The sides consist of a triangulated frame broken by the doors and windows. The additional stresses resulting through the excentricity of the joints from the load on the floor have been taken into account when calculating the system. Figures 15, 16 and 17 show respectively an outside view and two inside views of the body in light metals made by the Wegmann Works.

Fig. 15. — Body built of light alloys, for motor coach, figure 10, shown in course of erection.

The calculations take into account the vertically acting forces, the wind pressure, the centrifugal forces, and the vibrations.

All the joints have been calculated with great care, the reduced modulus of elasticity here playing a particularly important part.

Design of structural parts.

Special sections were not used for parts subject to tensile stresses; those parts under compression were on the other hand designed with as high a moment of inertia as possible as the modulus of elasticity of the material is only one third of that of steel. Ordinary 80 × 60 mm. (3 5/32 in. × 2 3/8 in.) rolled U bars are not always sufficiently strong in this respect, in spite of the reinforcement supports uniformly distributed along the sides.

In these cases, for example, for the cornice, a subdivided girder formed of two rolled U's connected together is made

Fig. 16. — Interior view of body, figure 15 (rolled sections and sheets of aluminium alloys).

use of. This section has also been utilised for girders subject to bending in two directions, or to torsion.

Joints.

Most of the joints have been rivetted. The first rivetted joints made with hot scleron rivets were unsatisfactory and experience showed that of the alloys considered, aeron (lautal) was better for rivets as it has a resistance to shear of 26 to 28 kgr./mm² (16.5 to 17.8 Engl. tons per sq. inch); the rivetting is done cold using 4 to 8-mm. (5/32-5/16 inch) diameter rivets.

8 and 10-mm. (5/16 inch-3/8 inch) rivets were only used occasionally. Unlike the practice in iron and steel, the number of rivets was made great and the diameter relatively small, so as to get good contact everywhere, the design providing for a large contact surface. In addition a small rivet diameter is to be preferred; the distance between the centres of the rivets measured in the direction of the loads was made 2 1/2 to 3 times the diameter, and the distance of the rivetting from the edge 1.6 to 1.8 times this rivet diameter. These proportions are based upon the greater deformability of the light alloys in comparison with steel.

Ordinary *welding* could not be considered, the mechanical and chemical strength being much too low. Assembly by *beaded edges* could not be used except for the panelling of the roof; this method makes it necessary to use annealed material the mechanical strength of which is lower. *Pin joints* were used in the brake gear and *bolts* were only employed in few cases.

Autogeneous or arc welding was not used, experience having shown that the

joints to stand up against vibration for any time must be carefully hammered which was scarcely possible in the present case. This method of jointing has however been considered for future cases.

The doors were either cast or built up of rolled section and rivetted plates (see fig. 18).

Static conditions.

The body of the vehicles presents three-dimensional static problems. The sides including the sole bars and the cornices have to transmit the vertical forces from the top bogie bolsters carrying the bogie pivots. In order to stand up to the horizontal forces acting across the body the sides have been stengthened up at the ends and in addition by pillars and intermediate pillars near the doors. Because of the opening needed for the doors and the electrical equipment it was impracticable to place the cross members in line with the pillars and the diagonal braces of the end, which would have greatly added to the rigidity of the structure as a whole.

The maximum load the bottom sides have to carry act under the end doors where the sides are broken; at these points considerable compression and shear stresses are also set up.

The buffing stresses are transmitted from the head stocks to the bottom sides which distribute them through the whole body.

In spite of this, however, the joints between these headstocks and the bottom sides have been calculated only to resist normal stresses so that in the event of collision the rivets are sheared and the destructive effects limited to the ends of the vehicles.

The layout of the body is clearly shown on figures 10, 12, 14 and 15.

Constructional details.

We have already spoken of the body side construction. The bottom side and the cornice are the same size throughout

Fig. 17. — Interior constructional details of body, figures 15 and 16.

their length although the stresses vary widely under normal conditions.

In fact, in case of collision, the direction in which the destructive forces will act cannot be foretold and as these forces play so great a role, it is necessary to make every part of the frame of equal safety. For the bottom sides the standard high tensile steel section has been adop-

ted; the cornices have been made of two rolled U bars of scleron alloy arranged in the form ⊏⊏ (see further down and fig. 23), the pillars being inserted each time between two sections. The outer panelling consists of 2-mm. (5/64 inch) aluminium alloy sheets between the doors. The waist rail was difficult to make

Fig. 18. — Double slide door in course of erection and fitted (type made of aluminium sheets and rolled sections).

owing to the spaces needed for lowering the windows. The ends are formed of a frame of U and L rolled sections covered with 2-mm. (5/64 inch) thick plates. The end windows are fixed.

The roof consists of 2-mm. (5/64 inch) light metal sheets and Z bars, the outer covering having beaded joints (see page 592).

The main frame is made up of the sole-bars, the main cross members, the head-stocks and the floor bearers (fig. 16).

The main bearers and the headstocks are of the usual type, in steel, the other cross members, on the other hand, are built up of ⊏⊐ rolled sections in light metal; the same design is used for supporting the auxiliaries (air compressor, auxiliary tank, etc.) (see fig. 19).

The bogies, as we said, at the beginning of this chapter, are exactly the same as those under the normal carriages.

As regards the interior fittings, not only saving in weight in itself but also the appearance in comparison with the existing stock was gone into. The interior panelling was done in light metal sheets in part painted to represent wood. The floor is of wood 25 mm. (1 inch) thick; it was not thought necessary to do much in the way of lightening the floor in view of the amount of steel used in the main frame.

Figures 20 and 21 show the inside arrangements of the 2nd and 3rd-class compartments.

The light vehicles built have the same spring gear as the standard steel carriages and also the same brake equipment.

It is intended, however, in order to reduce the weight still further, to go into the spring and brake gear in order to

Photo : Eng. Ad.-M. Hug.

Fig. 19. — Construction of support (built of light alloys) carrying the compressor and auxiliary apparatus.

compensate the greater difference between the loaded and empty vehicles. All the standard carriages are fitted with a device which, by means of a relay, regulates the braking force relatively to the actual load on the wheels; this regulation is done automatically when the doors are closed after each stop. This device was found necessary as with the rather lighter vehicles of the modified type a braking coefficient of as much as 85 % was reached which resulted in the wheels being picked up frequently.

Static diagrams and calculations (9).

In order to show the care with which the calculations were made, we will show below in relation with the diagram of figure 22 the checking of the dimensions of the cornices. The following suppositions where made : wind pressure on the vehicle normally 1 000 kgr. (205 lb. per

(9) The calculations were made for the « Metall Gesellschaft », at Frankfurt on Main, by F. Gentzcke, Bonn, in 1929.

Photo : Eng. Ad.-M. Hug
Fig. 20. — Interior of 2nd-class compartment of light coaches (aluminium sheets painted to imitate wood; also in figure 21).

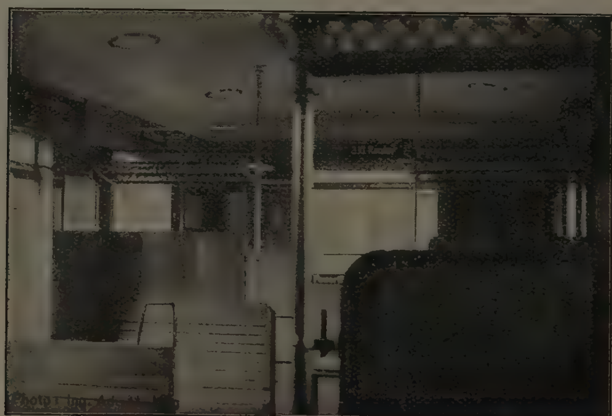


Photo : Eng. Ad.-M. Hug.
Fig. 21. — Interior of 3rd-class compartment.

sq. foot) and maximum 4 500 kgr. (9 216 lb. per sq. foot); speed 10 m. (32.8 feet) per second on curves of 180-m. (9 chains) radius; limit of elasticity of scleron 15.8 kgr./mm² (10 Engl. tons per sq. inch).

The section proposed is shown in fig-

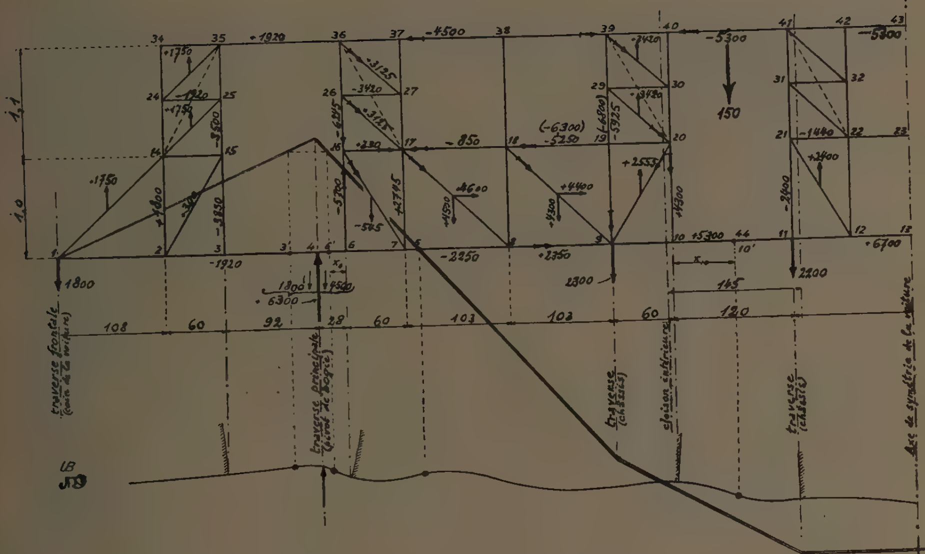


Fig. 22. — Static diagram of the structure of the body side walls (+ tensile stresses; — compression stresses, in kgr.).

Explanation of French terms:

Axe de symétrie... = Symmetry axis of coach. — Cloison intérieure = Intermediate partition. — Traverse châssis = Cross bar (frame). — Traverse frontale = Headstock. — Traverse principale = Main cross bar (carrying bogie pin).

ure 23. It should be noted that all these considerations affect the lightest con-

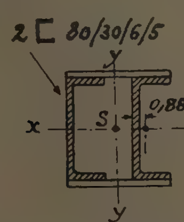


Fig. 23. — Proposed section for cornice of light alloys.

struction proposed (column C of table III, page 588) and not the four motor units built, the subject of this chapter.

Bending. — At the centre between the points 40 and 41 (see fig. 22) there is a shear stress the amount of which was calculated and which according to the diagram has to distribute a force of 2 200 kgr. (4 628 lb.) to the cornice and to the bottom side in proportion to these moments of inertia :

$$F_1 = 2\,200\left(\frac{122}{1\,800}\right) = 150 \text{ kgr.}$$

At point 40 the resulting moment is

$$M < 150 \times 60 < 9\,000$$

and the specific load

$$\sigma_1 = \frac{M}{Z_x} = \frac{9\,000}{30} = 300 \text{ kgr /cm}^2 \text{ (4 267 lb. per sq. inch).}$$

Buckling. — The cornice is held near points 40 to 41 by the intermediate partitions (mixed lines) and at point 38 by a main upright which in turn is held at point 18 by the seat. In consequence the buckling length has been taken as 150 cm. (4.92 feet) in the horizontal direction and 120 cm. (3.93 feet) in the vertical, that is respectively :

$$\frac{L}{R_y} = \frac{150}{4.5} = 33; \quad \sigma_B = 2\,250 \text{ kgr./cm}^2 \text{ (32 000 lb. per sq. inch).}$$

$$\frac{L}{R_y} = \frac{120}{2.95} = 41; \quad \sigma_B = 2\,000 \text{ kgr./cm}^2 \text{ (28 450 lb. per sq. inch).}$$

Between 40 and 41 a compressive force of 5 300 kgr. (11 460 lb.) acts causing a load of

$$\sigma_2 = \frac{C}{S} = \frac{-5300}{14} = -380$$

and

$$\sigma_1 + \sigma_2 = 680 \text{ kgr./cm}^2 \text{ (9 671 lb. per sq. inch).}$$

The factor of safety consequently becomes :

$$\frac{2\,250}{680} = 3.3$$

If the support due to the intermediate partition should fail, as for example after a collision, a buckling length of 3 m. (9.84 feet) would give a shear stress of :

$$\frac{L}{R_y} = \frac{300}{4.5} = 67, \quad \text{and} \quad \sigma_B = 1\,400$$

whence a factor of safety of

$$\frac{1\,400}{680} = 2.1\,.$$

The cornice is calculated so that it can take the load due to wind pressure, the centrifugal forces and braking stresses. If we take for example a permissible load $\sigma = 1\,500$, there remains available 1 500 — 680 = 820 for a horizontal force H acting at a point lying between 40 and 41; if the cornice be considered as a girder resting on a number of elastic supports we get :

$$\frac{145}{6} \cdot H = Z_y \cdot \sigma = 42 \times 800$$

whence

H = 1 400 kgr. (19 912 lb. per sq. inch).

The reaction of this force cannot be taken by the pillars so that the cornice may have to compensate for the stresses between the different pillars. The deformation of the intermediate partition will consequently have its influence on that of the cornices. Moreover, the centrifugal forces and the wind pressure combined can never reach the stresses calculated for H.

Even if the influence of the partitions be neglected so that stout pillars themselves carry the cornice, this latter is strong enough to stand up to the breaking efforts.

Some notes on the construction of the coaches in the shops.

Bending and planing the light plates was found to be difficult in the case of the scleron alloy, but was satisfactorily done with aeron-lautal. By means of special machines the results obtained were most satisfactory and the problem was

considered as solved. Bending the rolled section was much more complicated as it had to be done largely by hand, the small quantity not justifying the purchase of the different bending or curving machines that would have been needed. However a press was used with success especially when dealing with the large sections. The thin sheets were bent cold and the heavier plates, on the other hand, like the rolled sections, were bent hot up to as high temperatures as 450° C. (842° F.). To avoid too great deformation the hardening was done by air blast.

We have already spoken (page 592) of the connections and joints; there is much more that could be said on the experience obtained with rivets and rivetting but that cannot be included in the restricted scope of this article. As regards machining with cutting tools again, we cannot go into the details obtained with electric drills. When cutting sheets and rolled sections up to even 15 mm. (5/8 inch) thickness, woodsaws are used. All rivetted surfaces are coated with lead oxide free from any acid in order to prevent water getting in; this is especially important where light alloys are in contact with iron. It also prevents access through damp of possible acids especially sulpherous acids from the combustion gases of coal. The outside surfaces could have been left unpainted, in all the brightness of the aluminium, but it was realised that from an operating point of view the carriage must be painted like the normal stock.

The inside fittings also in alloys were forged or rolled in preference to castings, so as to make it easier to polish them. Great progress has since been made in making castings, especially by die casting.

All this part dealing with the construction in the shops, erection, treatment of the materials, machining, etc., has obviously been treated superficially and broadly. This subject could not be dealt with fully in a short article and we have had to be content with giving general indications and with mentioning some interesting items noted during the progress of the work. Naturally all these remarks apply to the case considered and can only be considered as of general application within limits.

Operating economies to be obtained.

Before starting on this matter the exact conditions which are to be taken into account in the case with which we are dealing must be stated; the hypotheses can in fact vary considerably. The principal factors controlling the lightening of the weight of the rolling stock are the following :

a) Total supplementary cost caused by the use of light alloys in the construction of the stock compared with the steel construction;

b) Consumption of current and percentage of current saved by lightening the motor and trailer stock;

c) Price of current measured at the bows or collectors of the motor vehicles;

d) Number of vehicles (or motor units) in service and average mileage run by the stock;

e) Advantages other than saving of current resulting from the reduction of weight (saving in brake shoe wear, saving in repair costs especially of the bogies, etc.);

f) Interest charges;

g) Amortization charges on the capital invested in the light vehicles.

An analysis of these factors would be outside the scope of this article, and we shall be satisfied with indicating how, for example, it would be possible, in the case considered, to calculate the economies that can be obtained; it is difficult to be very precise, the rolling stock in question having been in service for hardly more than one year. We may take the following figures for the heading given above:

a) Price per metric ton of light alloys = 4 500 gold-francs (4 572 gold-fr. per English ton) [10], and the average cost of steel construction = 300 gold-francs (305 gold-fr. per English ton);

b) The consumption of current of the motor vehicles per gross ton-kilometre = 46 w.-h./tkm. (75.2 w.-h. per Engl. ton-mile) [11];

c) Real average cost of current = 0.08 gold-franc per kw.-h. [12].

d) Kilometrage : 100 000 (62 140 miles) (annual average per motor unit);

e) The percentage of current saved cannot be stated yet and has not been taken into account as an advantage due to the idea that the true advantage naturally compensates for the error committed in taking the economy of current as proportional to the reduction of weight per unit realised;

f) Rate of interest = 8 %;

g) Rate of amortization = 1.4 % (25 years' life taken) [13].

In order to be able to compare the cost of this form of construction with that of steel vehicles, it would be necessary to know not only in this case the cost of the materials, but also the cost of labour. In the case with which we are dealing an exact comparison is hardly possible (both because of the many changes made in the drawings, and because of the small number of vehicles), but it has been possible to establish, none the less, that for the light alloys the labour cost of building is about 20 % less than in the case of steel construction [14].

Obviously with time and when there is experience, it will be possible to count upon less labour when building in light metals.

Comparative calculation of the saving obtained with the new as compared with the standard steel vehicles.

(Example of estimation.)

	(Gold-francs).
Cost of materials for steel construction [15]	32 500
Cost of labour and general charges.	68 800
Capital invested per motor unit [15].	101 300

The total weight of the body [15] was 32.8 t. (32.27 Engl. tons) for a unit (motor vehicle and trailer) and the parts not replaced by light metals represented

(10) These prices are if anything unfavourable for the aluminium, if we take the average market prices.

(11) In Winter this figure increases by about 22 % on account of the electric heating of the trains.

(12) The average price paid at the terminals of the high-tension lines at the sub-stations is 2.5 to 3 pfennigs.

(13) These 25 years have been taken as the average life for the whole of the motor units.

(14) With the VLW 14 B alloys now used and which have made a greater reduction of weight possible, the factor for labour has still further been reduced.

(15) Excluding the electric equipment.

about 21 tons, so that the parts that were replaced by light metals (rolled sections sheet and part of the wood) were about 11.8 tons.

If the parts are calculated at the rate of 300 gold-francs a metric ton, they will cost about 3 500 francs. For the more expensive parts of the body such as the bogies which cannot be replaced by light alloys, we may take the cost of these at 32 500 — 3 500 = 29 000 gold-francs.

The quantity of light alloys required to obtain a reduction of weight of about 6.5 tons for a motor unit is about 5 tons [16].

When calculating the price of the light alloys it is necessary to allow a supplement of weight of 5 % for scrap and losses during erection, so that the cost increases proportionately.

The cost of a unit (in gold-francs) is calculated therefore as follows, the electric equipment being always excluded :

	Steel construction.	Light construction.
Light alloys	—	23 200
Other materials	32 500	29 000
Labour [17]	68 800	68 800
	101 300	121 000

so that the additional capital invested = 19 700 gold-francs and the additional interest corresponding to 8 % is 1 580 gold-francs. The value recovered estimated at 1 500 gold-francs per metric ton is 5 × 1 500 = 7 500 gold-francs per unit, and has not been considered in the amortization charges, which for a life of 25 years give for the sum of 19 700 — 7 500 = 12 200 gold-francs, 1.4 % of 12 200, that is about 170 gold-francs.

The annual additional expenditure due to the use of light metals is therefore 1 580 + 170 = 1 750 gold francs.

The saving of current per motive unit and per annum can be calculated as follows :

Savings in weight [18] multiplied by the average kilometrage per unit, multiplied by the cost of the current per ton-kilometre, *i. e.*:

$$6.5 \times 100\,000 \times 0.0037 = 2\,405 \text{ gold-fr.}$$

In the case of the German suburban lines the reduction of wages therefore shows per unit and per annum a saving of 2 405 — 1 750 = 655 gold-francs, a remarkable nett economy, due above all to the fact that the traffic is extremely heavy and obtained in spite of the high rate of interest. If we consider, for example, a similar weight reduction for the whole of the stock, we should have obtained an annual saving of

$$655 \times 634 \text{ units} = 415\,270 \text{ gold-francs,}$$

that is, at the present rate of exchange, more than 2 million French francs, nearly 3 million Belgian francs, and nearly £ 24 000.

It would be possible to get out for such calculations a general formula as below for the annual supplementary expenditure of E :

$$E = i(Al \cdot P_{Al} - St \cdot P_{St}) + r[Al(P_{Al} - P'_{Al}) - St \cdot P_{St}]$$

or, estimating at one third of the new

(16) In fact, about 10 tons of light alloys were used for each unit, the reason being that in a combination not altogether favourable of steel and light alloys necessitating, through the different moduli of elasticty, sections larger than were required for strength.

(17) Taken at the usual rate in Germany for steel construction.

(18) Based upon that shown by the vehicles built by the Busch Works.

material the weight of the scrap recovered as regards the light metals :

$$E = i(Al \cdot P_{Al} - St \cdot P_{St}) + \frac{2r}{3} \cdot Al \cdot P_{Al} - r \cdot St \cdot P_{St}$$

or finally

$$E = (i + \frac{2}{3} r) Al \cdot P_{Al} - (i + r) St \cdot P_{St};$$

furthermore the economy of current can be expressed by

$$S = (St - Al) \cdot K \cdot L.$$

In these expressions the letters are used in the following sense :

Al the weight in tons of the light metals used;

St the weight in tons of the steel used;

P_{Al} the average price, in gold-francs per ton, of the light alloys;

the average price, in gold-francs per ton, of steel construction;

i the rate of interest;

r the rate of amortization according to the formula

$$r = \frac{i}{(1 + i)^n - 1}$$

in which n = the number of years over which the amortization is spread;

K annual kilometrage per vehicle (or unit;

L expenditure in gold-francs per ton-kilometre, depending upon the tare weight of the stock.

These formulæ can be used to get out approximately the economy effected, or that can be effected, by reducing the weight in all the cases in which fairly precise information is available. Deducting E from S, we can again show, in the case considered of the Berlin suburban lines, the influence of the variations in the fundamental factors affecting the cost of operation.

We wish to know, for a given type of rolling stock, under what conditions the reduction of weight effected or that could be made will be beneficial. We refer with this object to the data given on pages 600 and 601 and will consider the three following cases :

1st case : the value that the weight saving offers for different kilometrages per annum, or as a function of the operating costs.

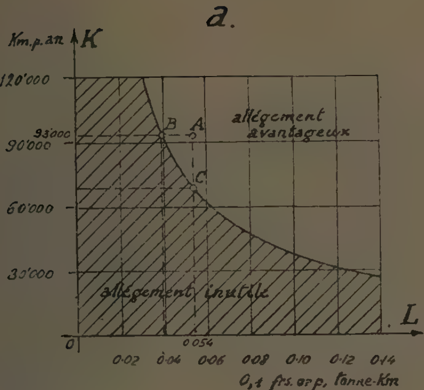
2nd case : influence of the fluctuations of the price of the light alloys upon the value the weight saving offers for different kilometrages per annum and in terms of the operating costs.

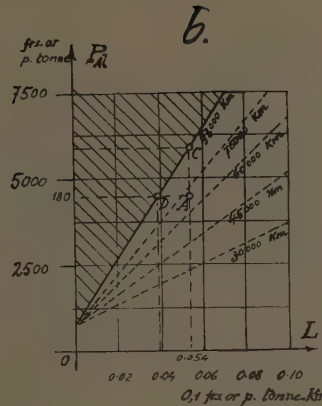
3rd case : influence of the variations in price of the light alloys upon the value of the lightening of weight in terms of the rate of interest.

These three cases are known respectively under headings *a*), *b*) and *c*) of figure 24 and can be explained as follows :

1st case. — We will suppose that the total of the supplementary costs due to the weight reduction are invariable; it follows that an increase in the kilometrage enables a reduction in weight to be made with advantage even when the operating costs decrease.

2nd case. — The other factors remain unchanged; when the operating costs are high (so far as these depend upon the dead weight, that is to say upon the tare of the rolling stock) a reduction of weight can be made with advantage even if the price of the light alloys is high.





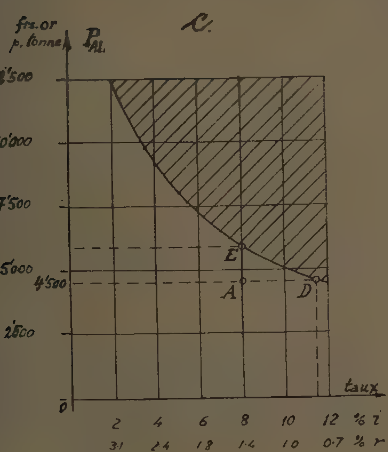


Fig. 24. — Limiting curves showing the value of profitable weight saving of rolling stock:

a) Kilometrage as a function of the cost of the ton-kilometre;

b) Cost of electric power as a function of the cost of the ton-kilometre for various kilometrages;

c) Cost of the light alloys as a function of the rate of interest.

Explanation :

Blank surfaces = Lightening profitable.
Hatched surfaces = Lightening useless.

A. Point corresponding to results achieved on the Berlin suburban lines.

B. Limiting point of value offered by lightening for a given kilometrage.

C. Limiting point of value offered by lightening for a given price of current.

D. Limiting point of value offered by lightening for a given price of the light alloys.

E. Limiting point of value offered by lightening for a given rate of interest on the capital invested.

Note : Taux = Rate of interest.

3rd case. — The operating conditions remaining unchanged the nett economy which can be effected depends chiefly upon the price of the light alloys and upon the rate of interest; it will be seen that for a high rate of interest a reduction of weight can only be made with advantage when the price of the light metals is sufficiently low.

It is clear that diagrams of this kind prepared, as we have specified, for the case of the Berlin suburban lines, can apply to all other operations and conditions.

Fig. 25. — Plan of the Paris Western suburban system (State Railways).

Explanation of French terms:

Lignes électrifiées = Electrified lines. — Lignes à électrifier = Lines to be electrified. — Usines = Power stations. — Sous-stations terminées et en cours... = Substations built or being built, with auxiliary distribution cabins. — Sous-stations prevues... = Projected substations with auxiliary distribution cabins. — Postes de sectionnement spéciaux = Special auxiliary distribution cabins. — Remisage et petit entretien... = Coach houses and daily maintenance of electric rolling stock.

III.

A new kind of trailer coach for the Western Paris suburban lines 1930-1931.

The French State Railways ordered in the summer of 1929 three hundred trailer coaches of a new type, in which light alloys were applied on a large scale; these carriages were to be used on the partially electrified suburban lines of the West of Paris (see fig. 25), and which formerly belonged to the Western Railway. It is not a question here of light metals applied the structure itself of the carriages but only to the whole interior and exterior panelling as well as the interior fittings. The reduction of weight obtained for each vehicle is about 2.2 tons, and applies to the exterior and interior covering of the body as well as the panelling of the roof. 1 500 kgr. (3 306 lb.) of light metal replaced 3 700 kgr. (8 155 lb.) of steel and iron. The same type of carriage

Fig. 26. — Trailer coach with panelling made of light alloys, for operation of suburban traffic, French State Railways.

when built entirely of steel has a tare weight of 40 370 kgr. (88 975 lb.) (19).

Figure 26 shows one of these 300 carriages as put into service in 1930-1931; figure 27 is a general arrangement of 100 of these carriages of type A_2B_2yfp with first and second class compartments (number of seats 1st class : 21 + 4 = 25; 2nd class : 63 + 4 = 67); 120 carriages are of type C_3 with three 3rd-class compartments, and 80 are of the type C_2E for third class with luggage compartment and are also fitted with a driver's cabin when running backwards (both for steam and electric traction).

These carriages had actually been designed so that they might be used not only on the lines operated with electric traction, but also on other suburban lines still operated with steam traction and shown by the fine lines in figure 25; on the French State Railways there are thus trains worked by steam traction able to run backwards and forwards.

In view of the relatively low power of the steam locomotive, as compared with the great flexibility of electric operation, the lightening of 5.5 % made it possible to the System to increase the capacity of the traffic of the lines. These trailer coaches were so constructed that they could be altered at a later date for electric traction.

Figures 28 and 29 show respectively the interior panelling of one of these carriages, and also the roof panelling ready in the works.

The alloys used for the suburban carriages were principally duralumin (140 kgr. = 308 lb. per coach); 450 kgr. (990 lb.) are either pure aluminium or alpax, or other alloys. It is of interest to give some particulars on the subject of the duralu-

(19) See *Revue de l'Aluminium*, Paris, No. 42, 1931, p. 1364-1370.

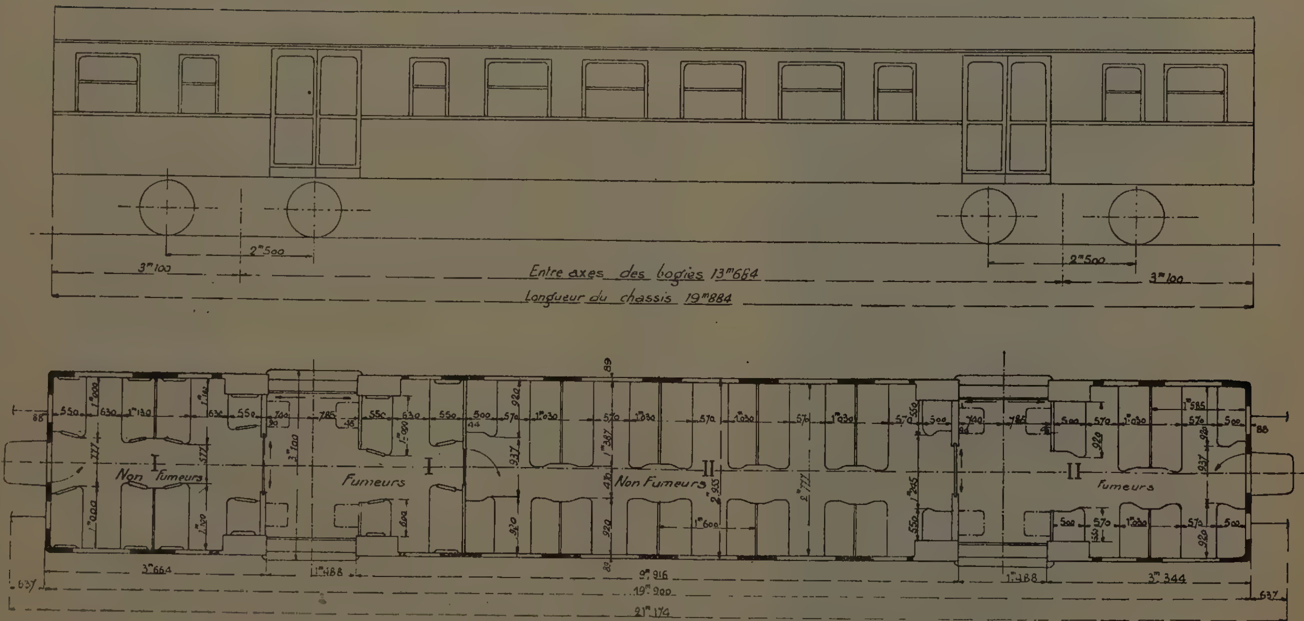


Fig. 27. — Elevation and plan of coach shown in figure 26.

Explanation of French terms:

Entre axes des bogies = Between bogie centres. — Longueur du châssis = Length of body. — **Fumeurs** = **Smokers.** — Non fumeurs = Non smokers.

Fig. 28. — Interior panelling of coach shown in figures 26 and 27.

min panelling used; for the interior, sheets of duralumin 1.3 mm. (0.047 inch) thick were used instead of 1-mm. (0.039 inch) steel sheets, and for the interior panelling of the roof, 1.3-mm. (0.051 inch) aluminium sheets of semi-hard quality were used. For the exterior roof panelling duralumin sheets 2 mm. (0.078 inch) thick were used in place of steel sheets of same thickness. The rivets are all of duralumin and the whole of the doors are cast in alpax; the weight of these doors has been reduced to 2/3 the weight of the normal construction, that is 40 kgr. in place of 60 (88 lb. instead of 132).

If we compare these suburban carriages of Paris with those of the Berlin suburbs, described in chapter II, we see that the lightening of carriages in the Paris suburban vehicles is only half (5.5 instead of 10), but it is necessary to remember that we are dealing with a series of 300 vehicles of normal construction built at one time. For the Berlin vehicles it is only a question of four units, that is in all of eight trial coaches in order to test the qualities of the light alloys for the construction of carriages running even at high speed.

The 300 French coaches were built by different Works : 150 by the Talbot

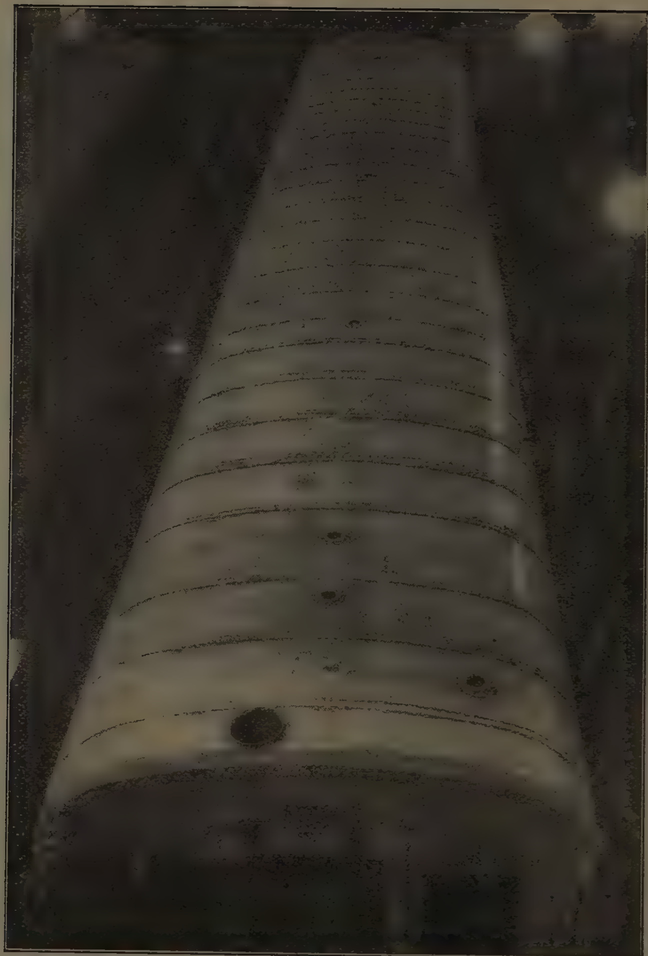


Fig. 29. — Panelling of coach roof.

Works, at Aix-la-Chapelle [20], 66 by the Entreprises Industrielles Charentaises Works, 50 by the Ateliers de Construction du Nord de la France (Blanc-Misseron), and finally 34 at the Carel & Fouché Works.

(20) As war reparations.

[656. 223.2]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

XIIth SESSION (CAIRO, 1933).

QUESTION VII:

Allocation of freight rolling stock. Investigation into the turn-round of goods vehicles. Separation of the elements included in it. Methods of reducing the period of turn-round [1].

REPORT No. 1.

(Germany, Denmark, Finland, Great Britain, Dominions and Colonies, Sweden, America, China and Japan, Norway, Netherlands and Colonies),

by W. F. H. VAN RIJCKEVORSEL,

Ingénieur, Chef du Service des Transports des Chemins de fer Néerlandais (Netherlands Railways).

A. — Allocation of freight rolling stock.

In the course of this report I shall endeavour to summarise briefly the replies to the questionnaire which I submitted to the Railways of Germany, North and South America, Great Britain (Dominions and Colonies), Denmark, Finland, Norway, Holland and Sweden. I wish to express my sincere thanks to those Administrations who have been kind enough to send replies.

Considering the important place occupied by the distribution of goods wagons in the working of a railway, it is essential to provide such distribution with an organisation which will be as efficient and as economical as possible.

In view of the severe competition which the railways have to face to-day, it is absolutely necessary for the wagon distribution service, in collaboration with the goods' trains operating service, to take steps to place wagons at the disposal of clients in the shortest time while reducing to a minimum the expense incurred by the railway.

In other words, it is essential to establish very close co-operation between the train working service and the wagon distribution service.

I. — *Definition of the problem of wagon distribution.*

From the information supplied most railways are under obligation to accept goods for transport, excepting only dangerous goods or other goods which are excluded by their nature.

The competitive means of transport (road motor, water, etc.) however are not subjected to this obligation. They can accept or refuse at will the consignments offered to them.

They will accept goods when the car-

(1) Translated from the French.

riage shows a profit, but they will refuse them, that is to say, they will leave them to the railways, when the transportation of such goods is less profitable or is difficult to arrange. Thus, the railways are left with many consignments which are not very profitable or which are burdensome to handle.

Another obligation which is against the interests of the railway is that of the disinfection of wagons which have been used for carrying cattle. This is a legal requirement which motor transport undertakings observe only to a limited extent or not at all in Holland. Insufficient disinfection, in the case of foot-and-mouth disease, may result in spreading of the disease.

In order to be able to meet its obligation as carrier, every railway possesses a sufficient stock of wagons to meet the traffic requirements as well as possible.

This stock must be sufficient to enable the railway to satisfy all requirements without delay when traffic is normal. This necessity becomes all the more imperative, since otherwise consignors will not fail to resort to other means of transport and thus the railways would run the risk of seeing traffic slipping away from them.

On the other hand, it is necessary to avoid as far as possible making use of the power of favouring, in periods of heavy demands, certain goods, such as foodstuffs, coal, export articles, perishable goods, cattle, etc., since if resort is had to this measure, it is likely to result in the carriage of other goods being lost.

It is preferable, in my opinion, to keep the traffic to the railway by resorting to other means, for example, by speeding up the circulation of wagons and by borrowing wagons from other railways as these will enable demands to be met.

It is also necessary, to get a rapid and adequate supply of wagons, that the demands for wagons should be carrefully drawn up so as to enable the railway to assign the most suitable wagons for the goods to be transported.

Inaccurately worded demands for wagons may result in disappointment to the consignors and may cause empty running.

If exactness in the demands for wagons is important in normal periods, it is all the more so in times of heavy traffic.

In practice, the railway utilises, first of all, the most suitable wagons amongst those which happen to be on the spot, thereby obviating empty running.

In case of wrong demands for wagons or failure to use the wagons, most railways make charges for demurrage or for non-utilisation.

Apart from the point as to whether this procedure is altogether desirable in view of the competition of other means of transport, it is advisable in my opinion not to abandon it altogether, because it is important, particularly in periods of increased demand, that arbitrary demands for wagons should be prevented as far as possible.

The supervising staff can also exercise an effective influence in this direction by keeping a constant watch on the regularity with which the wagons asked for are supplied.

A close examination of the scale of demands for wagons generally shows that these demands usually do not vary very much on the different days of the week.

There is often a drop in the numbers on Saturday, since on that day work stops earlier.

Furthermore if the days or the month are compared, scarcely any variations are observable.

Seasonal traffics produce, on the contrary, considerable differences on different railways, varying with the situation of the country, climate, etc.

The principal seasonal traffics are wheat, beetroot, potatoes, vegetables, hay, straw, flax, sugar, sugar cane, pea-nuts,

fruit, cocoa, coal, sheep, cement, cotton, motor cars, etc.

In comparison with the average traffic, the following variations amongst others are found :

87 % to 158 %
54 % to 137 %
60 % to 116 %
91 % to 108 %
90 % to 112 %
94 % to 105 %

II. — *Solution of the wagon distribution problem.*

With a view to effecting the maximum economy in the use of the wagons, it is necessary that the various organisations in charge of their distribution, both stations and distribution offices, should be able to communicate with one another easily.

As a means of communication, the railway telephone or telegraph (Morse), the Hughes telegraph or wireless are used almost without exception.

Rapid circulation of the wagons is thus ensured, which of course enables wagons to be supplied in good time when the demands increase.

Above all in regions where the competition of the road motor is felt must delays in making wagons available be avoided.

Standardisation of wagons in accordance with standards fixed by certain railways in common agreement, for example by the American railways at the instigation of the American Railway Association and by the Railways of British India by the Indian Railway Conference Association, also greatly facilitates a rapid supply of wagons, and all the more so since it facilitates repairing the wegons and cheapens the repairs.

The provision of a standard type for a definite class of wagon, for example all covered 15-ton wagons, affords the advantage that any covered wagon is suitable and may be assigned to satisfy a demand for a wagon of that sort without having to resort, as is often the case at present, to considerable shunting operations. In principle, the railways interested will assign wagons which happen to be in the nearest stations, thus reducing empty running to a minimum.

Consequently we notice a tendency towards the most extensive standardisation possible of the various types.

As to the number of classes, it will increase rather than decrease, owing to the necessity of acquiring wagons of ever increasing size.

The factor of the distance run empty which, according to the replies received, is attracting the very close attention of the railways, raises a debit item which is far from negligeable, and which is also brought out in the remarks made in connection with the construction of private owners' wagons.

Some railways exclude such wagons altogether, while others only allow them for certain goods which are specified in the railway tariff.

It cannot be denied that the registering of wagons belonging to private owners gives rise to serious inconveniences, for example additional shunting operations, increase in empty runs, and occupation of a considerable space in the stations, but on the other hand it also procures, in my opinion, considerable advantages because the owner of private wagons will be led to entrust his transport to the railway for preference, whereby the danger of traffic passing to motor transport or water transport is minimized. Moreover, in periods of growing demands for wagons, the wagons belonging to the railway will not be asked for to the same extent as if there were no private wagons included in the stock.

In addition, it appears to me to be an advantage to the railways, that owing to these wagons being available, they need not alter their own wagons or ac-

quire specially constructed wagons to meet technical progress in the different trades.

On the other hand, with a view to obviating empty running some railways, when convenient, provide covered wagons for goods which according to the tariff conditions should be carried in open wagons but which can be loaded without difficulty in covered wagons.

This is done especially when the destination stations only despatch goods which have to be transported in covered wagons. In this way, these stations are kept supplied with wagons and the number of empties sent to them is considerably reduced.

With a view to obtaining the most economical distribution of the wagons, the information provided by the stations must be as full as possible.

This point is all the more important in view of the existence of so many wagons of different type and tonnage.

The department in charge of the distribution of wagons should by a suitable choice of the wagons allocated constantly see that due respect is paid to the principle that as many goods as possible must be carried using the fewest possible wagons.

Following this line of thought, the scale of rates is usually arranged so that the unit cost of carriage falls as the weight loaded per wagon increases.

Some railways have drawn up regulations covering the running of certain given classes of wagons.

Thus, on the Netherlands Railways, the regulations require all open wagons not immediately required for new loads, to be despatched as soon as unloading is finished and without waiting for orders from the distribution office, to the concentration station indicated, whence they are distributed among the mines.

The object of this organisation is not merely to speed up the circulation of the wagons in question and to increase their yield as much as possible, but also to relieve the distribution office, which leads to an economy in the staff costs.

More rapid circulation is secured by virtue of the fact that stations are obliged to return without delay to the concentration station all wagons which cannot be used again immediately.

If a station has need of open wagons and has none available, it can draw from the wagons passing through this station towards the concentration station, or it may requisition them from a station before it in respect of the direction in which the wagons are moving.

In making the requisition, the station applying for wagons must take into consideration the train working.

If the station receiving the requisition is unable to satisfy it entirely or partly, it should inform the distribution office which in that case will use its influence to put the matter in order.

On the Netherlands Railways, however, the organisation is such that it is rarely necessary to ask the assistance of the distribution office.

Of course, if such an organisation is to be successful it is absolutely necessary for the running of the trains to be regulated in close accordance with the requirements as regards despatching wagons, in other words, whenever there is a sufficient load for a train at any station, the running of the train should be so regulated as to forward the wagons by through trains towards the concentration station in order to reduce the time elapsing between two successive loadings of a wagon.

Our inspectors and controllers must ascertain carefully whether the despatch of open wagons to the destination stations or their re-despatch from the intermediate stations is effected speedily, and to introduce where necessary arrangements for improving the train service.

Up to the present, this automatic working of empties only covers open wagons, which constitute 46 % of our stock, but the introduction of similar workings

is under consideration for the other classes of wagons.

Considering the numerous variations which take place in our country, where the seasonal traffics (vegetables, fruit, potatoes, etc.) are considerable, it will be appreciated that a very exhaustive preliminary examination of the statistical data at our disposal is necessary before this organisation can be set on foot.

The number of wagons required often varies widely from one day to another, sometimes over the entire railway, and sometimes in certain stations scattered over the entire railway.

The train service has then to be regulated so as to take into consideration the incessantly varying factor of the wagons which are to be brought to the stations where they are wanted, especially since for these classes of wagon it will be necessary to assign several concentration stations in order to meet the needs of the different parts of our country.

It is then necessary not to lose sight of the fact that stations must be able to draw, without too much shunting, the empty wagons for their use from the wagons moving to the concentration stations.

When the traffic decreases, railways are obliged to direct their surplus wagons to stations where the wagons may be stored without inconvenience to the service.

It is clear that if this operation is to be carried out under the most favourable conditions possible, various circumstances must be taken into consideration.

Thus, the wagons must be left standing in the stations where they will be required at short notice. On the other hand, the railway must clear those stations where the empty wagons are in the way, by sending the surplus wagons to destinations where there is more chance of being able to use them soon.

It will thus be possible in many cases to get the wagons back into service again without special measures (for example special trains) when the traffic increases again.

In order to distribute the wagons advantageously, it is necessary to deal with this part of the service with care.

The replies received show that this is done.

The empty runs should be as short as possible, unless by prescribing a longer route the wagons may be worked to destination more rapidly by existing trains.

It is essential to avoid crossworking empty wagons that is to say, running empties in opposite directions over the same section of line.

Finally, empties should be sent as far as possible by through trains with a view to avoiding loss of time in waiting in intermediate stations and possible shunting operations.

These measures all contribute in securing the maximum use of available wagons when the demands increase.

The importance to the railway of delaying as long as possible the time at which a shortage of wagons shows itself in times of heavier demands is clearly emphasised by the replies received, all of which describe the efforts made, in such an event, to work the traffic with the wagons available.

With this object in view, recourse is had to running special trains of empties, duplicating trains, introduction of night and Sunday working, opening shunting yards and sidings which in normal times are not used, shortening the periods for loading and unloading, etc.

This last measure, and others in addition, which inconvenience the public to a greater or less degree, such as charging demurrage, restrictions concerning the acceptance of certain goods on some week days should not, in my opinion, be taken except when those first mentioned show themselves to be no longer adequate.

Often also, in periods of heavy traffic, when covered wagons are scarce, other types of wagons (open wagons or cattle wagons) are placed at the disposal of consignors, with their agreement, instead of the covered wagons requested.

These open wagons are then covered with a tarpaulin or sheet by the railway.

In this respect, it may be stated again that the question as to the utility of possessing a certain number of wagons over and above those which are necessary for the average traffic has been answered in very different ways.

In my opinion, it is desirable to possess a surplus of 25 % of each class of wagon.

By this means, it will be possible not merely to satisfy more readily the demands for wagons when these demands increase, but also the cost of empty running will be considerably reduced, even in normal times. It is easy to show that these expenses will be reduced in fact by considering four stations at unequal distances apart each asking for a number of wagons, and by calculating the distances run empty in the case in which the total number of wagons present at all these stations is equal to, exceeds by 50 % and then by 100 % the number of wagons required, as shwon in the table on the following page :

It will be seen from this example that if the requirements for wagons remain constant, an increase in the wagons available in the stations is reflected in a diminution in the despatches of empties.

As I stated previously, several railways possess tarpaulins.

These tarpaulins are provided on demand to consignors or are supplied as needed for covering goods sent in open wagons which ought in principle to be sent in covered wagons.

These tarpaulins, like other loading tackle, ropes, chains, fencing, etc. are generally distributed in the same way as the wagons.

The personnel in charge of the distribution of wagons in the central or area offices should, in view of the extreme importance of making a wise use of the wagons and of the competition of other means of transport, make it its constant endeavour to supply the wagons in time.

It is therefore necessary that the orders for the despatch of empties issued by these offices, whether they are standing or daily orders should be carried out without delay and without question.

It is only on this condition that it will be possible in my opinion to meet the increasing trade demands.

In this line of thought, it is essential not to lose sight of the fact that a check of how the orders are carried out in general and of the way the wagons are treated in particular is required if need be on the spot.

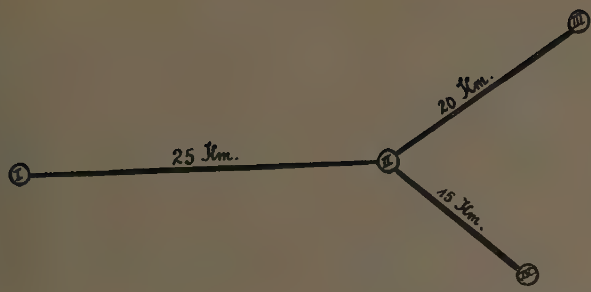
III. — *Control over the way distribution orders are carried out.*

All the railways consider checking the execution of distribution orders to be very important in order to get the work properly done.

Usually, the head of the offices allocating the wagons is responsible for effecting this control which is carried out at the office by comparing the rolling stock reports of goods' trains with the wagon situation returns sent in by the stations.

On examining closely these returns at the distribution office it is often found that stations have neglected to send in the reports which are necessary if the distribution is to work well, for example they do not report the arrival of loaded wagons which have come in after the time fixed for sending in their returns and which are released the same day. Or stations fail to advise the distribution office that wagons shown as necessary have been countermanded.

The effect of such neglect is to make the wagon position at these stations



Stations.	Number available.	Number required.	Excess.	Deficit.	Despatch order.	Distance run empty.
1st case : Number of available wagons = Number required.						
I	30	15	15	...	15 to II	15 × 25 = 375 wagon-km.
II	10	35	...	25	...	...
III	30	20	10	...	10 to II	10 × 20 = 200 wagon-km.
IV	10	10	...	...	...	...
Total. . .	80	80	25	25	25 to II	575 wagon-km.
2nd case : Number of available wagons 50 % more than in the 1st case.						
I	45	15	30	...	...	...
II	15	35	...	20	...	...
III	45	20	25	...	15 to II	15 × 20 = 300 wagon-km.
IV	15	10	5	...	5 to II	5 × 15 = 75 wagon-km.
Total. . .	120	80	60	20	20 to II	375 wagon-km.
3rd case : Number of available wagons 100 % more than in the first case.						
I	60	15	45	...	..	...
II	20	35	...	15	...	...
III	60	20	40	...	5 to II	5 × 20 = 100 wagon-km.
IV	20	10	10	...	10 to II	10 × 15 = 150 wagon-km.
Total. . .	160	80	95	15	15 to II	250 wagon-km.

easier than at those which strictly observe the instructions laid down in the matter.

Stations which give way to what misguidedly they imagine to be their interest generally tend to make their position comfortable by keeping as large as possible a reserve of wagons, especially in times of heavy traffic.

The wagon distribution department which should above all see that the distribution is effected fairly and as economically as possible ought to repress such actions with the greatest severity.

For this reason, most railways make officials specially appointed for this purpose responsible for checking at the stations themselves the information furnished in connection with the distribution of wagons.

Any irregularities noted are discussed and the attention of the staff is drawn to their duties with a view to the service being effected in a perfect manner.

In order to check the accuracy of the information furnished to the distribution office, some railways compare the data relating to two consecutive days.

Since it is impossible to control everything in detail and is moreover not indispensable, good results are obtained in this connection by making trial checks.

In regard to the Netherlands Railways, the following are a few points to which the staff in charge of the control have to pay particular attention :

1. Check on the job a return for a recent day.

2. Ascertain whether all the wagons, including those in the private sidings have really been shown as present.

3. Ascertain whether the number or wagons indicated as required to the distribution department corresponds to that of the wagons entered in the register of requests for wagons.

Also, whether the number of wagons specified to follow a route prescribed has been stated exactly.

4. Ascertain whether foreign wagons are utilised in accordance with the International Conventions, and particularly that their re-despatch to the frontier stations has not been delayed.

5. Ascertain whether any changes arising in the wagon situation as returned to the distribution department are immediately brought to the knowledge of this department.

6. Ascertain whether the distribution orders are carried out with the maximum possible speed, and therefore whether there are no wagons in the station which should already have been despatched empty.

7. Ascertain whether the time taken for loading and unloading is noted exactly in the documents.

8. Ascertain whether small material (tarpaulins, ropes, chains, fences, etc.) is treated with due care.

B. — Investigation into the turn-round of wagons.

Although most railways agree that, with a view to exercising satisfactory control, it is essential to take into consideration the time which elapses between two successive laodings of one and the same wagon (that is to say, the duration of turn-round or circulation), it follows from the replies received that the calculation of this time differs from one railway to another.

On the Netherlands Railways, the formula :

$$\frac{(A - B)\ C - (D + E) + D_1}{F} = X$$

is used wherein :

A is the total number of wagons of the type, the turn-round time of which is to be calculated.

B is the daily average of wagons of this type out of service for repairs.

C is the number of working days in the month.

D is the total length of time (working days) the wagons sent to foreign railways during the month are away.

E is the total number of wagon-days corresponding to the wagons not used (surplus) during the month. This number is obtained by adding up the number, day by day, of the wagons not used.

D_1 is the time which the wagons sent to foreign systems would have lost whilst unloading at the frontier stations if they had not been sent abroad but instead to the frontier station.

F is the number of loaded wagons despatched from the stations on the railway itself during the month.

X is the turn-round time in internal user.

Of course, the calculation is only made as regards the circulation of wagons belonging to the railway on the railway itself, foreign wagons being left out of consideration.

Experience teaches in fact that, in order to employ the wagons as profitably as possible, the factors having an unfavourable influence on the turn-round must be ascertained and eliminated.

I have in mind here particularly the time required for transferring the wagons of one train to another running in connection with it, the time required for putting the wagons in position at the destination stations, the time elapsing between loading or unloading and the departure of the wagons, etc. In the first place, therefore, the railway interested ought itself to take steps whereby the turn-round period can be reduced and a greater traffic handled with the same number of wagons.

It is this consideration which led me to cut out the time spent by the wagons abroad, and to calculate the circulation solely for internal service.

With a view to being able to judge with knowledge whether the turn-round period corresponds to that which can be reasonably demanded, a check is made from time to time, on the Netherlands Railways, of :

1. The time lost in the despatching station between the moment loading is completed and that at which the wagon is formed in the train.

2. The time travelling in train formation.

3. The time spent at stations where the wagon has to be transferred.

4. The duration of the journey as far as the destination station.

5. The time required for placing the wagon in position at the loading banks or on the private siding.

6. The time necessary for advising the consignee.

7. The duration of unloading.

8. The time required for despatching the wagon to another place or station for re-loading.

9. The time required for re-loading.

If the calculation of the turn-round shows at a certain moment that the latter has become more unsatisfactory, the various elements composing the turn-round are examined and steps taken to improve those elements capable of such improvement.

If prescribed in good time, these steps will, in my opinion contribute to delaying, if they do not avoid, the taking of other steps which are unpopular with both consignors and consignees, such as for example, shortening the period for loading and unloading, charging demurrage, etc.

Rationally enough, the railways will endeavour by any other means to meet the demands for wagons. Mention may

be made of the organisation of special trains, particularly for long distance runs, extension of working period, if necessary also on Sunday, the use of more powerful locomotives also for shunting.

Some railways speed up the turn-round of the wagons still further by organising special trains for parcels and by running empty wagon trains.

Several railways also grant rates reductions for consignments by complete trains.

With the object of reducing the time wagons remain in station, demurrage is charged when the loading and unloading periods have been exceeded, while some railways prepare for certain marshalling yards statements showing when the wagons received should leave.

If it happens that wagons are not despatched by the booked trains, the reason for this is sought, and if necessary improvements are made in the service.

Railways allow time for both unloading and loading. On some railways the period is extended when the consignor or consignee is located at a considerable distance from the loading or unloading station.

When these periods are exceeded, demurrage is charged.

The periods allowed are generally ample, because the number of wagons on which demurrage is charged is comparatively small. The rates for demurrage increase progressively.

The raising of the demurrage rates in periods of heavy transport is exceptional.

Bonuses are not granted for rapid unloading and loading within the demurrage periods.

On some railways however (North America) the interested parties have the choice of different methods of calculating the demurrage charges.

There is first of all the ordinary method in which each wagon is charged separately for demurrage at the expiration of the period allowed, and then the conventional calculation, in which a definite reduction is allowed for every wagon unloaded or loaded within the period allowed.

For the wagons coming outside the period, the demurrage due is carried to account.

The total of the demurrage charges for the wagons delayed is reduced by the total credit due to the wagons that were released quickly.

This balance is taken out monthly.

Most railways advise the consignee of the arrival of loaded wagons either immediately or after the wagons have been put into position for unloading.

The advices are sent by porter, or by post or are telephoned or telegraphed.

As a general rule, when empty wagons, that is to say wagons asked for, are placed at disposal, no notification is made, and in my opinion quite justly so, since the consignors have ordered these wagons and will therefore have determined themselves the moment at which the wagons ought to be supplied.

It follows that when the railways are not in a position to provide the wagons at the desired moment, they ought to advise the consignor, that is to say, the person who has ordered them.

On some railways, either the loaded wagons arriving, or the empty wagons at the station or both are announced by sticking bills showing the consignee as regards the loaded wagons, or the consignor whom they may suit, as regards the empty wagons.

It has not been possible, of course, for me to reproduce all the replies in this brief account, but I hope that the foregoing will serve as a guide to the discussion on these questions.

SUMMARY.

The conditions to be fulfilled if the distribution of rolling stock is to be a

good one as regards meeting operating requirements are :

1. The stock should be distributed rapidly and economically.

2. The turn-round of both loaded and empty wagons should be as quick as possible.

In order to get this it is desirable in the case of loaded wagons to make use of the through trains.

As regards sending empty wagons, it is necessary that this stock move automatically by using the through trains to the principal wagon despatching centres.

The other stations can be kept supplied automatically in the same way.

3. The circulation of the goods trains should be arranged to suit the needs of the system.

4. The public should be attracted to the railway by cutting out as far as possible irritating regulations, that is to say the application of demurrage charges, charges for not using wagons supplied, etc.

5. The types of wagons should be standardised as far as possible.

6. Private wagon ownership should be encouraged by the railways who fear the loss of traffic to other competing forms of transport.

7. The clerical work in connection with demands for wagons as also that in connection with the delivery and unloading of loaded wagons should be reduced to the barest needs.

8. Foreign stock should be used as largely as possible within the regulations in force.

9. Collaboration of the railway and the road should be facilitated (by, amongst other means, using containers).

[656. 212 6 & 656. 225]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

12th SESSION (CAIRO, 1933).

QUESTION VIII:

Organisation for carrying small consignments of goods and the most suitable methods for their delivery with the least delay. Use and selection of fixed and mechanical transhipping plants (1),

by C. FETTARAPPA,

Ingénieur, Inspecteur en chef au Service de l'Exploitation des Chemins de l'Etat italien, Rome.

REPORT No. 2

(All countries except America, Great Britain, Dominions and Colonies, China, Japan, Belgium, France, Spain, Holland, Portugal and their Colonies, Switzerland, Finland, Luxemburg, Norway and Sweden),

The transport of parcels represents a traffic which, while being considerably less pretentious than that of transport by complete wagon loads, is none the less necessary and important for the general well-being of the community. The transport of parcels constitutes a very close network of small consignments which, crossing and intersecting in all directions, are formed of a great variety of products for satisfying the infinite demands of life, and are despatched in packages of many different kinds.

The organisation of such transport is consequently very complex, since it necessitates a close and incessant study of the traffic currents and of the most useful arrangements to be made for rationally re-grouping the consignments and the resulting operations, so as to ensure rapid and regular transport, without losing sight of the rational and economical utilisation of fixed plant, rolling stock and personnel.

The problem has assumed particular importance in recent years, during which the general commercial crisis has been aggravated to an ever-increasing extent by the competition of the road motor vehicle.

Before proceeding to examine the different elements of the question, it would appear expedient to set down the definition of transport of parcels as given by the Administrations who have replied to our questionnaire.

The Italian State Railways consider as parcels consignments rated at charges which are not related to a minimum

(1) Translated from the Italian.

weight per wagon. The following are not considered as parcels :

1. Consignments, the weight of which attains 5 000 kgr. (11 000 lb.)

2. Consignments occupying three-quarters of the capacity of a covered wagon.

3. The consignment of a bulky package which on account of its dimensions requires a wagon to be used for it alone.

4. Consignments of goods for which the consignor has applied for the exclusive use of a wagon.

5. Consignments of goods which by their nature may not be loaded up with other goods.

6. Consignments of loose goods and those which are despatched without packing and might mix with other goods or be damaged by them.

7. Consignments of goods necessitating the use of special wagons.

In stations which are not equipped with the means required for loading and unloading packages weighing more than 3 000 kgr. (6 600 lb.), the administration may require the consignors and consignees to carry out these operations.

On the Bulgarian State Railways, packages are considered to be consignments of different goods in small quantities, not exceeding 3 000 kgr. (6 600 lb.). Packages of a weight greater than 2 000 kgr. (4 400 lb.) are loaded and unloaded by the consignor and consignee.

On the Greek Railways (Pirea-Athens-Peloponnesus), parcels consignments are called « partial loads ». These are consignments of a weight and dimensions such that each does not fill an entire wagon. Each package should not exceed the weight of 3 tons.

On the Egyptian State Railways, parcels consignments are considered to be those of a weight less than the chargeable minimum of 4 tons, provided for complete load consignments.

On the Yugoslavian Railways, the definition of parcels consignments applies to those of a weight of less than 5 000 kgr. (11 000 lb.), unless application has been made for the exclusive use of a wagon. Loading and unloading are carried out by the railway, except in the case of packages 7 m. (23 feet) or more in length and weighing more than 500 kgr. (1 100 lb.).

On the Czechoslovakian Railways, consignments of parcels are those charged for a weight of less than 5 000 kgr. (11 000 lb.).

The German Reichsbahn applies the definition of parcels consignments to those composed of light packages and generally accepted by the office of the station or the auxiliary offices. No limit to the weight or volume is mentioned. The consignor is obliged to load packages of a weight exceeding 500 kgr. (1 100 lb.) or packages wich cannot be loaded into covered wagons.

It will be seen that, passing from one railway to another the consignments falling in the category of parcels transport differ rather considerably. This diversity in the limits of weight and volume results in an appreciable variation in the proportion existing between the weight of goods despatched as parcels and the total tonnage of goods carried on the lines of each railway.

Actually, this proportion is approximately 10 % on the Yugoslavian Railways, 9 % on the Italian State Railways, 4.2 % on the Czechoslovakian Railways and 2.5 % on the German Reichsbahn.

If to this proportional variability we add the differences in the commercial development and organisation of the various countries, the differences in the importance, configuration and extent of the various railway systems, the nature, intensity and direction of the traffic currents, varying from one railway to another, we are forced to conclude that the organisation of parcels transport cannot be uniform on all railways, but

must be adapted to the conditions and needs of the economic region served by each railway.

Various forms of transport are provided for forwarding parcels. On the lines of all the railways that have replied to the questionnaire there is fast transport and slow transport.

Some railways have two forms of fast transport, namely : a) *Accelerated fast transport* for valuable goods, perishable goods, small urgent packages, etc. which are usually sent by passenger train (for example, on the Italian State Railways, there are express parcels and very perishable goods which are sent by the fastest passenger trains, and other consignments which are sent by slower passenger trains) ; b) *Ordinary fast transport* for goods in general which are sent by ordinary goods trains or by slow passenger trains.

Most parcels are despatched by slow transport, being generally sent by ordinary goods trains. Hence, a satisfactory organisation of such slow transport forms an economic item of paramount importance in railway administration. There are different rates and scheduled delivery periods for each form of transport, and if these periods are exceeded, the responsibility of the railway varies from one administration to another, even for one and the same form of transport. Although these differences may influence the organisation of the transport in different ways, as regards speed of delivery, each administration feels the necessity for improving its own organisation in order to provide transport which will be as rapid as possible with a view to meeting the ever-increasing competition of the motor lorry, and to satisfy the requirements of commerce which, in the present economic situation, tends to reduce its stocks of goods so as to avoid locking up large amounts of capital, and for this purpose divides its orders into small quantities which are renewed more frequently. Consequently, the necessity for effecting the transport by rail of goods in detail simply, surely, economically and above all rapidly, is becoming more and more pressing, particularly in those regions where the menace from the competition of motor lorries is greatest.

The expression « parcels » employed in the text of Question VIII will be taken as covering both fast traffic and slow traffic, so that the discussion will be given the necessary amplitude. It would also appear useful to divide the report into several chapters in their chronological order.

CHAPTER I.

Acceptance of consignments.

The acceptance of parcels consignments is effected in all stations open for the service of parcels transport, and the goods are offered by the consignor at the warehouses and at points fixed by each administration according to its own internal regulations and the local provisions. The Italian State Railways and some other administrations, with the object of facilitating transport from the door of the consignor to the departure station and to speed up transport, have organised in the more important towns a service for collecting parcels at the door of the consignor by means of private transport undertakings authorised by the railways to do this by virtue of a regular contract and at rates and under conditions made known to the public.

We are of the opinion that this service, suitably intensified and organised, with frequent and inexpensive means of transport is capable of exerting a very favourable influence in meeting the competition of the motor lorry.

In order to satisfy better the requirements of the public in large commercial centres, the German Reichsbahn and the Italian State Railways generally have in the large towns several stations authorised to accept parcels (for example, Ber-

lin has six of these stations on the outskirts of the business quarters, and Milan has five at different points in the town). In some important centres of Germany served by a single departure station, there are also auxiliary offices for accepting transport, combined with the office of forwarding agents approved by the railway.

As a general rule, parcels consignments are accepted and deposited in the departure sheds, except in the case of goods loaded on industrial sidings, when some administrations consent to the formation of wagons of parcels within the establishment or works, with the assistance of an employee from the railway.

In certain stations having an intense parcels traffic, the Italian State Railways also accept, for direct loading into wagons, consignments of important batches intended for a single station or for several stations of a definite zone.

On the Czechoslovakian State Railways, goods in detail are as a rule accepted in the warehouses. However, consignors are authorised, for a certain quantity of consignments (1 500 kgr. = 3 300 lb.), to load goods directly into wagons which they have requested for their exclusive use. This system enables a saving to be effected in the costs of handling the goods but results in the use of a larger number of wagons.

On the Bulgarian Railways, in important stations receiving daily large numbers of consignments for certain stations, loading into the wagons is sometimes effected directly by the consignor.

Direct loading into the wagons affords the advantage of obviating the handling of packages in the warehouse, and may be useful for the rapid despatch of consigments by the departure station in exceptional cases of numerous batches or of considerable quantities of goods for certain destinations, when the nature of the goods allows the operation of weighing to be eliminated, or when the latter may be done at the destination station, and when the wagon may be conveniently utilised and at once held ready for departure by the scheduled train. In periods of more intense traffic, direct loading may form an additional effective means of preventing crowding of the warehouses and its harmful repercussions on the delivery of consignments.

Parcels are generally accepted every day (except Sunday and holidays, as regards slow traffic) and for any destination, with the object of satisfying the requirements of commerce in the best possible manner. For the same purpose, it may be useful to extend the hours for the acceptance of consignments on days or during periods when there is an increase in traffic.

The acceptance of consignments every other day for certain directions may be advantageous from the point of view of the satisfactory utilisation of wagons and the formation of wagons of parcels for distant stations, while economising intermediate transhipments. This procedure is only adopted on the Italian Railways in certain important localities and as a result of agreements with certain firms, but it is not general nor is it provided for in the tariffs.

The other Railways who have replied to the questionnaire have not adopted this system.

The rules regarding the information which packages handed over for despatch must bear vary from one railway to another.

On some railways, such as the Italian State Railways and the German Reichsbahn, the packages have to be labelled with the information necessary for identifying them and despatching them properly to their destination according to the instructions appearing on the waybills. The railway only affixes additional labels in special cases (for instance, packages bearing lead seals affixed by the customs officials, consignments with a declaration of interest in the delivery).

On the Czechoslovakian Railways, the

departure station provides packages only with a label bearing the name of the despatching station, while other information (marks, numbers, destination station and address of the consignee) is put on by the consignor. On other railways (Bulgarian State Railways, Egyptian State Railways), the consignor is not bound to label packages and the railway undertakes to do this.

It is preferable for the labelling to be done by the consignor owing to a saving in time and labour, but it necessitates exact checking of the agreement between the information appearing on the packages and that shown on the way-bills. Labelling done by the railway is more expensive but affords a greater security from the point of view of the regular despatch of consignments.

As a general rule, the railway administrations check the weight of the packages acepted at the warehouse for despatch, even if the consignor is obliged to declare the weight on the way-bills. The weighing operations represent an appreciable loss of time during the departure operations. In order to speed up despatch it would be of advantage to provide in stations of intense traffic numerous weighing machines, preferably automatic, situated at the most suitable points of the goods acceptance shed. (At Halle in Germany goods brought for despatch enter by 21 doors, near each of which is an automatic weighing machine.)

The packages are handed over at the same time as the way-bills, and the system of booking the consignments varies from one railway to another.

With a view to speeding up the loading and despatch of parcels, booking is effected very simply and very rapidly on the German Reichsbahn. In order to speed up the operation of computing the charges, this railway has established, in the large stations, special offices responsible for the preliminary examination of way-bills. These offices are generally situated near the acceptance windows. In some important stations large racks containing metal plates corresponding in number to the destinations of consignments leaving these stations, are provided for each acceptance window. (At Halle, each rack contains 4 000 plates). These plates have embossed on them the bases of the charges for parcels for weights rising from 10 to 400 kgr. (22 to 880 lb.) in 10-kgr. (22-lb.) stages, for each destination station which is indicated on the bent-over edge visible on the outside of the rack. The employee in charge of the acceptance of goods withdraws from the rack the plate corresponding to the destination of the consignment and with the aid of a small printing machine he prints on the top of the way-bill the information appearing on the plate, which thus acts as a printing plate. The clerk who computes the charge has then only to mark with a pencil the rate represented by the figure corresponding to the weight of the goods previously checked by means of the automatic weighing machine.

A system of this type simplifies and considerably speeds up the operations of accepting goods and computing the charges for their transport, but it necessitates rather expensive appliances, as well as a simple scale of charges having a uniform basis for parcels. If it can be employed, it may be very useful and profitable for stations with heavy traffic where the costs of installation may be recovered by a considerable saving in staff.

As a general rule, the way-bills accompany the packages to their destination. The German Reichsbahn, however, allows way-bills to be sent by passenger trains only if the train appointed for transporting the goods departs before the transport documents are ready. In this way, the documents, while leaving after the goods, will arrive at the destination before them.

The warehouses where parcels are ac-

cepted should be sufficiently spacious and easy of access for the public, so that goods waiting for despatch will not remain there longer than is absolutely necessary. It should be possible to remove the goods from private vehicles, group them in the warehouse according to destinations and load them on the wagons easily, rapidly and regularly. The equipment should be capable of meeting the intense daily work in periods of heavy traffic.

Rapid and regular acceptance of goods calls for an active and skilled staff in order to carry out promptly all the operations involved in the acceptance and loading of parcels. This staff should have a perfect knowledge of the routes, and the points of transit and forwarding, so as to be able to prepare the proper grouping of the packages before they are loaded on the wagons.

A system which gives very good service is to provide in the warehouses diagrams (preferably divided into sectors) indicating the stations to which the consignments should be forwarded and the routes to be followed.

The position of the warehouses should be such as to facilitate the shunting of wagons in and out of them.

CHAPTER II.

General organisation of parcels transport.

In the preceding chapter, the reasons were given why the organisation of parcels transport cannot be uniform on all railways. Consequently, the organisations existing on certain important railways will be dealt with separately.

German Reichsbahn.

Fast transport. — During recent years, the fast transport of all parcels has been organised in a general manner in the tranship centres, special rules being applied in regard to fast loads. This measure has resulted in :

a) the possibility of providing more frequent means of forwarding consignments on the same day ;

b) direct loading for very distant tranship centres ;

c) a satisfactory utilisation of wagons;

d) a reduction in the duration of transport.

The fast transport of packages in detail is organised on lines similar to that of the slow transport of packages in detail, with the sole difference that if a fast consignment is under consideration, the greatest importance is attached to the speed of transport, even though this may result in a less satisfactory utilisation of the wagon.

Slow transport. — The railway staff are provided with instructions showing how they must deal with goods during loading, on the journey and during unloading, in order to ensure regular forwarding according to a well-established programme and in order to avoid loss, damage and mis-directing of goods.

The rules relating to loading indicate and prescribe the proper tranship stations for each loading station (traffic route). The slow transport of parcels has to be effected in the quickest way, transhipments being avoided as far as possible. When a sufficient tonnage is available, several wagons are despatched each day from the stations of origin of the consignments or from the tranship centres according to predetermined programmes, otherwise the goods are held back for a maximum period of 24 hours. An endeavour is made above all to make up the largest possible number of wagons loaded with parcels for a single destination, because the goods thus arrive at their destination directly without being transhipped. The surplus is always made up according to a predetermined programme into wagons of parcels destined for a certain tranship centre and collec-

tion and distribution goods wagons are made up in the intermediate stations. Each station is surrounded by from four to six tranship centres and the proper tranship centre for each traffic connection has now been fixed permanently once and for all.

The tranship centres may be either *concentration centres* for goods in despatch, or *transit and connection centres* or finally *distribution centres* for arriving goods.

By *concentration centre* for consignments in despatch is meant a definite tranship centre towards which the consignments intended for a definite zone flow. By *distribution centre* for arrivals is understood a tranship centre from which consignments may be forwarded directly to the destination station. *Transit and connection centres* are tranship centres which serve for forwarding goods in each particular direction.

As a result of the complete re-organisation of the service, the German Railways have in all 116 tranship centres, of which only 40 serve as transit and connection centres. Since the German Railways extend over a length of about 800 km. (500 miles) both in the north-south and in the east-west directions, the distance between the tranship centres is about 74 km. (800 divided by the square root of 116), or 46 miles.

Despite the large differences existing between the whole of the traffic streams in the various directions, Germany has few stations which are more than 100 km. (62 miles) from the corresponding tranship centre.

Due to this organisation, goods despatched to the most distant destinations (up to 1 000 km. = 620 miles) are as a rule not transhipped more than three times, namely at the concentration centre, at the transit and connection centre and finally at the distribution centre.

The reduction in the number of transhipments has a favourable influence on both the operating costs and the rapidity of transport. On the contrary, economy in rolling stock is far from providing the same advantages, in view of the fact that a considerable quantity of rolling stock is always available, due to the economic crisis and the ever-growing competition of other means of transport.

Italian State Railways.

The organisation of the parcels transport is based briefly on the same fundamental principles as that in force on the German Railways. On the Italian Railways also, wagons of parcels are made up for a single destination, wagons of parcels are made up for a definite unloading zone or a zone terminating in a suitably situated tranship centre, and collection and distribution wagons of parcels are made up in the intermediate stations.

In making up the above-mentioned wagons, absolute priority is given to the first-mentioned, because these wagons carry the goods directly and rapidly to their final destination without any transhipment. It is only after this that wagons are loaded with goods intended for an unloading zone of for a tranship centre as remote as possible, so as to reduce the number of transhipments to a minimum.

The difference between the German system and the Italian system resides in the fact that, on the German railways, all the wagons of parcels are made up according to a fixed programme which is laid down beforehand, while on the Italian railways only some of the wagons are made up in accordance with a predetermined programme, the programme for the others being optional and left to the initiative of the local supervising staff. This difference is due to the fact that, on the Italian Railways, the traffic currents are very variable and peculiar to the seasons, and is also due to the obligation of making up wagons for tranship

centres which are as remote as possible. In addition, since the whole of the traffic for the most distant destinations may vary every day, the result is that wagons cannot be constantly made up for one and the same tranship centre.

Another difference between the two organisations lies in the fact that, on the Italian Railways, transhipment of parcels and particularly fast consignments, on the most important lines, is not effected in the stations alone but also during the journey, by employees who accompany the train, this being done with the object of grouping the goods so as to avoid as far as possible their transhipment at the nearest point of transit. For this purpose, wagons are made up which are able to continue their journey by the train making connection at the point of transit without the necessity of any operation other than that of shunting of the wagon. (On the main lines, fast long-distance trains are run comprising in their composition wagons communicating with one another by vestibules similar to those used on passenger trains, with a view to facilitating and speeding up the work of transhipment while the train is running.)

Due to the organisation of this service, the Italian Railways have reduced the number of transhipments to a figure not exceeding two on the average. The organisations existing on the other railways who have replied to our questionnaire likewise tend to speed up the transport of goods by reducing the number of transhipments to the lowest possible figure.

The Czechoslovakian State Railways have adopted an organisation which aims chiefly at rapidity of delivery, even at the cost of the utilisation of rolling stock. In this way, they have succeeded in not going beyond the average of two transhipments.

On less important railways, such as those of Greece (Pirea-Athens-Peloponnesus and Turkey (Smyrna-Cassaba) the necessity for the special organisation for the transport of parcels does not exist, owing to the configuration and limited extent of their systems.

CHAPTER III.

Loading and forwarding parcels.

In stations of intense traffic, goods are loaded into wagons immediately after acceptance, thus obviating the necessity for warehousing them. Only goods for less important destinations for which the wagon can only be made up with the consignments of the whole day, and goods which are to be subsequently loaded into wagons in transit, are then deposited in the warehouse.

Direct loading into wagons affords the advantage of obviating double handling of the goods with its resulting expense and possible damage to the packages. In certain cases also, it may enable the goods to be despatched more promptly.

This system is adopted by the Italian, German, Czechoslovakian, Bulgarian and Egyptian Railways. On the Yugoslavian Railways, loading is done at the end of the day, after the consignments have been grouped by destinations, with a view to securing a rational utilisation of wagons. However, these railways recognise that some consignments cannot be loaded on the same day as their acceptance. Satisfactory utilisation of the wagons is not, however, always ensured and mistakes in forwarding may be made more easily.

The average length of time the goods wait, from their acceptance to their departure, varies from one administration to another, because it depends upon the extent of the railway, the intensity of the traffic, the frequency of the trains carrying the goods and the importance of the stations. In regard to fast transport, efforts are made to despatch goods several times a day by the most suitable trains. The less important passenger trains even are utilised, particularly on

secondary lines. However, for long distance transport, a fast service is provided by a single daily train having a long run, whereby consignments are able to arrive more quickly at their destination.

Slow transports are despatched once a day when the operations of loading are finished for the day. Actually, it is during the late hours of the afternoon that consignors usually hand over the largest quantities of goods. In zones of heavy traffic, however, wagons may also be despatched in the morning.

In order to effect prompt delivery of slow-transport consignments, the fundamental rule followed by the important administrations is *to load by day and transport by night* on lines where this system is compatible with the working conditions, and where it is not excessively costly.

In stations of some importance, loading of goods for fast transport is generally carried out also by night and on Sundays and holidays. On the Italian State Railways, this system is applied to all stations with the exception of those which are not open for night service.

In the most important stations on some railways, loading of consignments for slow transport is likewise done by night and on Sundays and holidays.

Night work, while advantageous from the point of view of the prompt despatch of consignments is not adopted very much because it is less productive and is consequently more expensive than day work, and also because it involves greater risks of damage to the packages and mistakes in forwarding them. With the object of avoiding night work, the working hours preferably extend from the early hours of the morning to the late hours of the evening.

On railways where the service of goods trains transporting slow parcels is suspended on Sundays and holidays, the transport suffers a delay of 24 hours. On the Italian State Railways goods trains also run on Sundays and holidays.

On the Yugoslavian Railways, goods are forwarded in :

a) *station* wagons for a single destination station ;

b) *zone* wagons for stations on one and the same line which form a section (zone) according to special prescriptions;

c) *transhipment* wagons for a large tranship station and for the stations situated beyond ;

d) collection wagons *for local service or for branch lines* (« pick-up » wagons) normally running on a definite section of line in trains allotted to this service ; in these wagons, all the stations on the line load packages for a definite station or for stations situated beyond this station.

The minimum weight laid down for making up the wagons enumerated under *a*), *b*) and *c*) is 1 500 kgr. (3 300 lb.) for fast goods and 2 000 kgr. (4 400 lb.) for slow goods.

The wagons mentioned under *a*) and *c*) are forwarded directly to the destination station without any handling of the goods during the journey, by mixed trains, accelerated goods trains and, if necessary, by passenger trains, if it is a question of fast goods, and by through or accelerated goods trains, if it is a question of slow goods. The wagons mentioned under *b*) are forwarded like those mentioned under *a*) and *c*) as far as the station where the unloading section begins, and after this station, by pick-up trains.

The wagons mentioned under *d*) are put into circulation daily without limit in weight and according to a fixed programme. They are forwarded by mixed trains or by goods trains appointed beforehand, and those conveying fast parcels may also be forwarded by passenger trains. After leaving the station where the goods are transhipped into wagons for a single destination, the latter are

forwarded like those referred to under *a*).

All the wagons mentioned in the foregoing are accompanied by a special lading bill on which are made all the entries relating to the loading, unloading and the removal or application of the lead seals.

On the Italian State Railways, the following classes of wagons are employed for conveying parcels :

a) *Normal* wagons which are put into circulation daily or periodically, but only by certain stations without limit as to weight and according to a pre-established programme. These wagons serve to collect goods intended for a single station or for several stations of a definite zone or section of line ;

b) *Supplementary* (occasional) wagons which may be put into circulation by any station having the prescribed quantities of goods for a single station (*local wagons*) or for several stations of a definite section of line or of the zone dependent upon a tranship centre (*through wagons*). The minimum weight prescribed is 1 500 kgr. (3 300 lb.) of fast goods or 2 000 kgr. (4 400 lb.) of slow goods for local wagons, and 2 000 kgr. (4 400 lb.) of fast goods or 3 000 kgr. (6 600 lb.) of slow goods for through wagons.

This limitation of the weight cannot be adhered to in the following instances :

a) in the case of dangerous or noxious goods which may not be loaded with other goods or which necessitate the use of an open wagon ;

b) in the case of packages which cannot be split up and of a weight not less than 500 kgr. (1 100 lb.) ;

c) in the case of goods which will not pass through the doors of covered wagons.

For slow goods intended for the ports, the weight limit of 3 000 kgr. (6 600 lb.) is reduced to 2 000 kgr. (4 400 lb.). For certain ports, it is even reduced to a still lower figure.

For goods imported from abroad, the frontier stations may make up wagons of goods in detail without any limitation as to weight.

Normal wagons are forwarded by collection and distribution trains for parcels. Supplementary wagons are forwarded by the fastest goods trains on the lines or sections of line if the wagons themselves do not require any operations of handling during the journey.

Accelerated fast goods, charged at the rate for fast goods increased by 40 % are forwarded by accelerated passenger trains or, on the more important lines, by certain accelerated goods trains supplementing the said passenger trains and having the same speeds characteristics. Goods charged at the rate for fast goods increased by 70 % are forwarded by through passenger trains. The packages transported by passenger trains are carried in the luggage van which, on lines of heavy traffic, is supplemented by a special wagon coupled to the luggage van and communicating with it like the coaches of passenger trains.

On the more important traffic routes, there is also an express parcels service for parcels not exceeding 30 kgr. (66 lb.) in weight. These parcels are subject to special charges for each route and are carried in the luggage van of certain through passenger trains.

A service of this type has recently been organised for the transport of urgent goods which are carried to the consignee's door as soon as possible after the arrival of the train, by a private transport undertaking approved by the railway. At the request of the consignor these goods may also be collected at his door and conveyed to the departure station also by the private undertakings several hours before departure.

Each wagon of parcels, either fast or slow, is accompanied by a special bill on

which the fast goods are noted in a lump (quantity and weight) by each station effecting loading and unloading operations in the wagon, while the slow goods are noted separately for each consignment. This difference in treatment between the fast and slow goods is due to the fact that the very short length of stop of the fast collection trains in the intermediate stations necessitates reducing the clerical work to a minimum. Regulations are being considered with a view to simplifying the clerical work relating to the transport of parcels with a view to securing a more rapid and economical service.

On the German Reichsbahn, wagons of parcels are divided into two categories :

a) *Normal* wagons, the purpose of which is to collect goods and to transport them to the tranship centres or to distribute directly those coming from stations or tranship centres;

b) *Complete* wagons of parcels that is to say, wagons loaded with goods for a single destination or for different destinations of a definite zone and intended for the corresponding tranship centre.

Wagons of fast parcels are forwarded either by long distance fast trains (B O), or by short distance fast trains (Ne) or by passenger trains (P).

Complete wagons or slow goods are as a general rule forwarded by long-distance goods trains, and normal wagons by short-distance goods trains.

On the German Railways, the normal wagons which are to be put into circulation daily according to a predetermined programme are made up without the application of a minimum tonnage. Complete wagons of parcels are made up for a minimum of 1 500 kgr. (3 300 lb.) of fast goods and 2 000 kgr. (4 400 lb.) of slow goods.

On certain days, or in certain fixed months, stations are obliged to make up occasional fast wagons to meet the exceptional rush of goods (for example, goods from markets, consignments of fruit varying with the seasons, etc.). For slow goods, there are wagons running regulary according to a fixed programme (regular wagons) and wagons which are put into circulation when necessary (optional wagons).

Complete wagons of parcels may be made up, irrespective of the weight of the consignment :

a) when their capacity is utilised ;

b) when it is impossible to load them with other goods at the same time ;

c) when it is a question of packages of exceptional weight and dimensions ;

d) when, due to the customs formalities, it is advisable to make up a special wagon ;

e) when it is a question of goods being sent to ports for overseas export, or to the concentration points for empty wagons. This case is governed by a special order.

The Reichsbahn employs daily for the transport of parcels a total number of 35 000 to 40 000 wagons, four-fifths of which may be regarded as being « regular » wagons.

On the German Railways, each wagon of parcels is accompanied by way bills only enclosed together in a wrapper (loading dockets are not made out).

On the Czechoslovakian State Railways, *local* wagons and *distribution* and *collection* wagons are made up for consignment of slow parcels.

Local wagons loaded with fast goods for a single destination may be made up with 1 500 kgr. (3 300 lb.) or even with a weight of less than 1 000 kgr. (2 200 lb.) on routes where the competition of the motor lorry is most menacing.

The *distribution* and *collection* wagons are made up daily in accordance with a definite programme for the removal and distribution of goods.

In addition to the two categories of

wagons mentioned above, there are, for slow traffic of parcels :

Transhipment wagons containing goods for all the stations of the zone dependent upon a tranship centre, and *group wagons* for goods intended for a group of stations situated one after the other.

According to requirements, the stations may make up supplementary (occasional) wagons for a minimum weight of 2 000 kgr. (4 400 lb.). In the special cases of motor competition or perishable goods, they may even make them up for certain localities with 1 000 kgr. (2 200 lb.) of goods.

Wagons of fast parcels are forwarded as a general rule by passenger trains. Perishable goods are carried almost exclusively by slow passenger trains, unless they can reach the destination stations in the same time or earlier by a fast goods train.

Wagons of slow goods are forwarded :

a) by pick-up goods trains;

b) by long distance express goods trains;

c) by collection and distribution trains (« Leig » trains).

Trains *a*) and *c*) stop at all stations and serve to collect and distribute goods.

The trains mentioned under *b*) serve for forwarding wagons on lines or sections of line when the wagons themselves do not necessitate any operations of handling during the journey.

Each wagon of parcels is accompanied by waybills relating to the different consignments and a paper (envelope) on which all the consignments loaded into the wagons are booked and which also serves for the unloading operations.

A simplification of the above-mentioned clerical work is under trial as regards the pick-up goods trains.

From what was stated in the foregoing, it follows that in making up wagons of parcels the principle observed is that of assembling and forwarding the largest possible quantity of goods in full wagons so as to convey them directly and rapidly to their final destination or to a suitably situated transhipping centre. The object of operating in this way is to speed up transport and to reduce the number of transhipments by limiting to the strict minimum the number of daily collection and distribution wagons put into circulation, considering that these wagons are circulated slowly in local trains and are generally little utilised.

An endeavour should be made to despatch all parcels, whether fast or slow, on the same day as their acceptance. Despatch should only follow acceptance, however, after the time which is necessary and sufficient for ensuring careful handling of the goods and proper loading has elapsed. It may be of advantage to retain the slow goods for a length of time not exceeding 24 hours in the warehouse or in the wagon which is being made up, when such a step enables transhipments to be avoided, or when by this means it becomes possible to assemble goods in wagons which are satisfactorily utilised and are proceeding to distant destinations. In no case, however, ought this retention of goods have the effect of causing the scheduled period for delivery to be exceeded. On the Italian Railways, it is permissible to make up slow wagons with goods in detail accepted during the course of two consecutive days, that is to say, to delay the departure of the goods accepted on the first day by 24 hours, but only when, by this means, it is possible to make up wagons loaded with goods for a single destination or for very distant tranship centres. In such cases, a special control is exercised for the purpose of ensuring that the application of this rule does really result in speeding up the delivery of long-distance consignments without delaying the forwarding of short distance consignments.

Parcels transport results in a restricted utilisation of the capacity of the wagons, both in weight and in volume, either due to the particular characteristics of weight and destination or owing to the necessity of effecting their arrival at the destination as rapidly as possible.

For some years, this necessity has become more and more imperative under the effect of the transport crisis and motor competition. The consequence has been to accentuate increasingly the contrast between the rapidity of delivery and the amount of goods transported in each wagon. However, this contrast does not involve a greater use of wagons allocated to the transport of packages because the more rapid circulation of the wagons implies a shorter time between two consecutive loads, and hence, ultimately, less use of rolling stock.

The result is that, on the large railways, the average use of wagons for parcels tends to diminish.

On the German Railways (Reichsbahn) the average loading of such wagons has been the following :

1929	1.14 t.	for fast goods.
1930	1.06 t.	
1929	1.35 t.	for slow goods.
1930	1.27 t.	

The following are the corresponding figures for the Italian State Railways :

1929	1.94 t.	for fast goods.
1930	1.88 t.	
1929	2.25 t.	for slow goods.
1930	2.07 t.	

Railways generally affix to parcels wagons labels indicating the category and use of the wagon, these labels consequently differing from those applied to complete load wagons. This special labelling is of particular importance because it assists the regularity and rapidity of the operations of loading and unloading the goods and shunting the wagon.

The regulations in force on the Italian and German Railways lay down priority, for despatch, of wagons of parcels over wagons with complete loads. In addition, on the Italian Railways, the labels affixed to local or transhipment wagons of parcels also indicate the trains by which the wagons are forwarded; on the Reichsbahn, all the parcels wagons of any category carry labels with this information, but these labels are distinguished from those affixed to complete load wagons by a special border.

During periods of intense traffic, the railway administrations resort to the most appropriate and most useful measures for preventing overcrowding of the warehouses and delays in despatching consignments (such as, for example : reinforcing the staff and increasing the number of working hours, Sunday and night work, running goods trains on lines where such trains do not run on Sundays, increasing the charges for warehousing, reducing the length of time allowed for consignees to remove goods, making up supplementary wagons of parcels for certain routes).

Parcels are generally transported by the route for which the charges have been fixed. It is expedient to employ different routes when, by diverting goods on to more important lines or on to lines which are more advantageous for the trains conveying the goods, it is possible to speed up the transport.

On some railways (Reichsbahn, Yugoslavian State Railways, Czechoslovakian State Railways, Bulgarian State Railways, Greek Railways), the handling of parcels (loading, unloading, transhipment) is done exclusively by the railway staff. On others, such as the Egyptian State Railways, it is done by private undertakings for the railway, which is directly responsible to the public, while the contractor is responsible to the railway for damage. However, the intervention of the private undertaking is confined to the operations of loading and unloading.

On the Italian State Railways, the

operations of loading, unloading and transhipment of parcels is generally done by private undertakings in the large stations, while in the others it is carried out directly by the railway staff. It is only in certain large stations that the private undertakings also provide the service of acceptance and deposit in the warehouses, as well as that of booking the goods and making up wagons of parcels.

The Italian State Railways consider that the service entrusted to private undertakings is more advantageous from the point of view of rapidity and economy of transport, more particularly during those periods of intense traffic which are peculiar to the seasons, the private undertaking being able to procure more easily labour proportionate to the fluctuations of the traffic.

Other administrations, such as those of the Yugoslavian and Bulgarian Railways share this view, but consider that the service provided exclusively by the railway staff affords better guarantees from the point of view of regularity and safety of the transport.

The use of containers for grouping consignments intended for one or more stations has not yet been adopted by the Italian Railways or the other administrations who have replied to the questionnaire, with the exception of the Reichsbahn where as a general rule special containers are used for loading consignments such as milk cans which by their nature demand careful handling, or consignments formed of numbers of small parcels which may easily be lost, or finally for packages accepted without packing (cheese, cloth, etc.) in order to meet the competition of motor transport. These containers, which are adapted in their shape and dimensions to the nature of the goods to be transported (small cases, large cases, wheeled cases, trays with or without shelf, large baskets, etc.) are largely employed by the German Railways in the Leig trains which are dealt with in Chapter IV (figs. 1, 2, 3 and 4).

It is beyond doubt that the use of containers is avantageous from the point of view of protecting goods, saving labour for handling the goods and rapidity of loading and unloading, but they represent a fairly heavy charge for the railway both in regard to first costs and cost of upkeep and because they constitute additional weight which is carried free of charge. At all events, the problem is still being studied and tried out on several large railways.

In more important localities served by several goods stations or sheds, it generally happens that goods have to be passed from one station or shed to the other in order to despatch them by trains and lines terminating in a certain station. This results in inevitable delays in despatching goods. In addition, a certain number of wagons are occupied in such transfer of goods from one station to another in the same locality. These disadvantages also occur in the case of arrivals intended for different stations or sheds in the same locality. With a view to effecting rapid arrival of partial consignments coming from different lines or to forwarding rapidly consignments intended for different lines, it may be advantageous in the localities in question to make use of motor lorries on the road for transporting packages from one station or from one shed to another in the same locality. A service of lorries of this type, connecting the stations on the outskirts of large towns is under consideration by the Italian State Railways and is being tried out in some important localities of the German Railways where the lorries make 3 or 4 trips daily in each direction so as to ensure rapid and frequent transfer of goods. The lorries belong partly to the Reichsbahn and partly to contractors. The drivers are recruited as far as pos-

Fig. 1.

Fig. 3.

Fig. 2.

Fig. 4. — Container with double bottom (loaded).

sible from among the weighmen authorised to drive lorries.

This organisation is an internal one, the object of which is to enable the public to despatch and receive its goods at the nearest railway office, even if the consignments in question do not, technically, come within the zone of traffic routes pertaining to that office.

In certain localities on the Czechoslovakian State Railways where traffic conditions are particularly difficult, parcels, both those arriving and those accepted for despatch, are conveyed from one station to another in the same locality by means of motor lorries. These lorries run according to a pre-established time-table, so as to ensure all connections being made.

From the economic point of view, this lorry service represents an expenditure for the railway by virtue of the first cost, and the maintenance and running costs of the lorries, but it may be justifiable as a means of speeding up delivery of parcels in order to retain traffic or to bring it to the railway, particularly in regions which are most affected by the competition of other means of transport.

The transportation of parcels over short distances (up to 100 km. = 62 miles, for example) coming from or going to a large station or in transit through this station are at the same time generally threatened most by the competition of the motor lorry and are most subject to delays for reasons connected with the operation of the large railway establishments at which they are to arrive or through which they must pass.

On railways where this disadvantage is felt to any serious extent, the question is being subjected to a close examination with a view to ascertaining the most effective measures to be taken, either by means actually pertaining to the railway or by auxiliary means.

CHAPTER IV.

Trains for conveying parcels.

Fast goods. — On the most important railway systems, where the fast traffic represents an appreciable tonnage, either long distance or short distance fast goods trains are run.

On lines over which the above-mentioned trains do not run, use is made of certain goods trains conveying both fast goods and slow goods, and even of passenger trains of lesser importance when, owing to the nature of their time-table, routes and service, they are able to assure a better transport of the goods.

The use of the different categories of forwarding trains is regulated in each administration by suitable instructions according to the requirements of the operation of the railway and to the traffic conditions.

On less important railways, where the fast traffic of packages in detail is inconsiderable on the whole, there is no special organisation of trains for the despatch of fast parcels. Generally, use is made of passenger trains or mixed trains.

Slow goods. — For these goods, long-distance goods trains and short-distance passenger trains are used.

Long-distance goods trains have a high average speed and generally only stop at the most important stations. In addition to complete load wagons, wagons of parcels which have not to undergo any handling during the journey are sent by these trains.

The *short-distance goods trains* provide the local service and stop at almost every station. These trains convey completely loaded wagons, empty wagons, complete wagons of parcels and wagons for the collection and distribution of parcels in the intermediate stations. Generally, they make lengthy stops in each station for the operations of load-

ing, unloading and shunting. As a general rule, they do not run in the night, because loading and unloading would be more difficult, if not impossible, on lines of lesser importance where there is no night service.

It is rational to run long-distance goods trains during the night and short-distance goods trains in the early hours of the morning, so that goods may be placed at the disposal of the consignee on the day of their arrival, the connections in the transit stations being made with the necessary care.

It is good practice to place wagons loaded with parcels in a single group in the train so as to facilitate handling in the intermediate stations. In addition, this arrangement obviates the necessiy of passing the wagons through shunting sidings on the arrival of the train in tranship stations so that the wagons may be set directly and rapidly at the tranship stage.

Complete wagons of parcels travelling in long-distance goods' trains and intended for the intermediate stations at which these trains stop, should be classified in the geographical order of the stations so as to simplify and speed up the shunting operations. With a view to the satisfactory utilisation of locomotives there are generally no trains assigned exclusively to the service of slow parcels, except in the special case of a line on which the parcels traffic is particularly intense.

As a rule, on all the railways, the staff appointed to the service of trains transporting parcels are not specialised in this service but have to attend equally to all trains. However, it is an advantage to make use as far as possible of the same employees, so that they will acquire special practice in the work of handling goods which is to be done at the different stations on a definite line, this being in the interests of the regularity and rapidity of this work.

The parcels service is regulated by special instructions given to this staff. The operations of loading and unloading in the intermediate stations are carried out by the train staff in conjunction with the station staff.

Thé average figures for the running and average speeds of the different classes of goods trains assigned to the transport of parcels on the lines of the administrations who have replied to the questionnaire are as follows :

	Running speed.		Average. speed.	
	Km.	*(Miles)*	Km.	*(Miles)*
Long-distance fast trains.	60 to 70	*(37 to 43.5)*	30 to 45	*(18.6 to 28)*
Fast trains	50 to 60	*(31 to 37)*	20 to 25	*(12.4 to 15.5)*
Long-distance slow and fast goods trains.	40 to 60	*(25 to 37)*	20 to 35	*(12.4 to 21.7)*
Short-distance pick-up trains.	35 to 45	*(21.7 to 28)*	10 to 15	*(6.2 to 9.3)*
« Leig » trains	60 to 70	*(37 to 43.5)*	20 to 30	*(12.4 to 18.6)*

The transfer of parcels as between train staff and as between this staff and that of stations is effected on most railways in accordance with the way-bills. The consignments are entered into books provided for the purpose or on the loading dockets, according to rules and formalities which vary from one administration to another.

On the German Reichsbahn, this transfer is done in accordance with the waybills. This system undoubtedly affords the advantage of speeding up the operations of loading and unloading by avoiding loss of time in booking and in signing receipts. The other administrations have not yet deemed it useful to adopt this system because they do not desire to abandon the greater guarantees provided by the system of handing over in accord-

ance with the loading books or dockets, as regards fixing the responsibility of the staff in case of loss or mistakes.

Due to the always pressing necessity of rendering delivery more rapid and economical, it is expedient to examine means of simplifying the above-mentioned clerical work and reducing it to a minimum, if not to dispense with them entirely as on the German Railways.

The simplification of the clerical work is at present under examination and test on several railways (Italian and Czechoslovakian State Railways).

The service of removing and distributing slow parcels in the intermediate stations provided by long, heavy and very slow trains, utilised at the same time for shunting and for conveying complete load wagons is now held to be out of date and is considered as not answering any longer to the present needs of traffic. In addition, it is much slower than the service provided by motor lorries on the road. It is therefore necessary to ascertain suitable means for remedying this situation. With this object in view, the German Reichsbahn has instituted and developed for some years a new organisation of rapid and light trains for the short distance transport of packages.

As befits their purpose, these trains, called « Light parcels trains » (Leichte Stückgüterzüge) or, abbreviated « Leigs », are short and light so as to attain a fairly high speed [65 to 75 km. (40.5 to 46.5 miles) per hour] and reach the warehouse sidings directly and rapidly.

In some stations, where access to the warehouse is not possible, movable gangways operated and readily put into position either manually or mechanically, connect the loading platform to the floor of the wagon across the track (fig. 5).

In order to provide sufficient room for loading and moving the goods during the journey, the wagons constituting the « Leig » train form a unit which acts as a travelling warehouse. Consequently, different types of formation have been adopted :

One type (fig. 6) is constituted by a luggage van of 4.50-m. (14-ft. 9 in.) wheelbase and a wagon chosen from among the longest of the stock (wheel-base 7 m. = 23 feet), connected together so as to form a unit.

The two vehicles are connected closely together by a short coupling with central draw and buffing gear, and their ends have been opened so that they form a single unit. The short space (about 35 cm. = 13 3/4 inches) separating the two vehicles is covered by a plate forming a gangway enclosed by a vestibule which is supported on an end cross member. An actual travelling warehouse is thus formed having an effective loading area of 40 to 44 m² (431 to 484 sq. feet) and a length of 15 m. (49 feet).

Another type (fig. 7) is similar to the foregoing with the difference that, instead of the luggage van, it comprises a second wagon having a long wheel-base (7 m. = 23 feet) at the end of which there is left a small compartment for the guard of the train. This system has been adopted in order to increase the above-mentioned loading area by about 10 m² (107.6 sq. feet) (effective area 50 m² = 538 sq. feet, effective length 19 m. = 62 feet approximately).

Yet another type (fig. 8) is formed of a single rail motor car (Maybach-Diesel 150-H.P. engine, four speeds, the top speed being 65 km. = 40.4 miles per hour) having a capacity of 76 m³ (2684 sq. feet) and carrying 15 tons.

The interior of the train is provided with electric light, heating, a lavatory, a small table and a rack for the papers.

In case of need, any type of « Leig » train may be supplemented by the addition of, at the most, two wagons, in order not to diminish excessively their mobility and rapidity of shunting, a consideration to which paramount importance is attached.

Details concerning the operation and

Fig. 5.

Fig. 6. — « Leig » train on the Reichsbahn (German State Railways).

Fig. 7. — « Leig » train on the Reichsbahn (German State Railway Company).

Fig. 8. — « Leig » train of the Reichsbahn, consisting of a rail motor van.

organisation of these trains, together with the results obtained have been discussed at length : *a*) in the Report by Mr. Leibbrand on Question XII of the Madrid Session, 1930 (see *Bulletin of the Railway Congress* for February, 1930, page 585); *b*) in the *Zeitung des Vereins deutscher Eisenbahnverwaltungen*, No. 43, 24th October 1929; *c*) in No. 7, July 1930 of the *Bulletin of the International Railway Union* (U. I. C.).

The Reichsbahn runs these « Leig » trains in almost every direction. At the end of August, 1931, they numbered 260.

On the other hand, the Italian Railways have introduced special fast and light trains called « *treni rapidi collettame* » (fig. 9) for the transport of parcels on some lines having an intense traffic and more particularly threatened by the competition of the motor lorry. Hauled by low-powered locomotives, these trains of fixed formation comprising a luggage van and several wagons (from 5 to 8) which have electric light and communicate with one another by vestibule connections so as to form a single travelling warehouse (fig. 10), are equipped with continuous brake, run at a speed of 60 km. (37 miles) per hour and make short stops at intermediate stations. They carry staff who effect the operations of loading, unloading and transhipment during the journey. Their light formation enables them to attain high travelling speeds and to arrive rapidly at the goods stations so that the operations of loading and unloading can be performed readily and promptly. During the journey, the train crew prepare the packages for rational unloading and make use of the communication existing between the vehicles to carry out the necessary transhipments of packages from one wagon to another.

Very careful attention has been paid by the administration to the drawing up of the timetables so that the consignments carried between stations of lines over which the trains in question run shall arrive at their destination on the same day as their acceptance or in the early hours of the next day, according to the distance. It has been possible to obtain this result by assigning to each wagon well-defined functions in regard to the quantity and destinations of the consignments, so as to reduce to a minimum the transhipments to be made during the journey and to obviate them entirely in exchange stations, in which the wagons are transferred from one train to another connecting train, according to their function, by shunting alone and hence without transhipping the goods. In drawing up the time-tables, particular attention has been paid to the agreement in the stations in question between the arrival and departure of these trains from and for the various lines, so as to reduce the length of the stops to the time which is strictly necessary for carrying out the operations of splitting up and reforming the trains.

Generally, the service is provided by two pairs of trains daily, so that it is possible for stations to despatch goods, a few hours after their acceptance, by the two trains at their disposal in the course of the day.

On the lines served by these trains, the slow local trains for picking up and distributing parcels (pick-up trains) have been abolished. In addition, the scheduled run of some other ordinary goods trains has been reduced, so that finally there has been no increase in the train-hours ; on the contrary, it has been possible to effect a diminution on some lines. Consequently, there has been no increase in the locomotives and staff employed.

The wagons employed have a fixed working when in use, just in the same way as passenger coaches, so as to avoid empty runs entirely. The time between two successive loadings is very short. Thus, for example, the complete service of these trains on the lines Turin-Milan, Milan-Verona, Verona-Venice, Bolzano-

Fig. 9. — « Rapido collettame » train on the Italian State Railways.

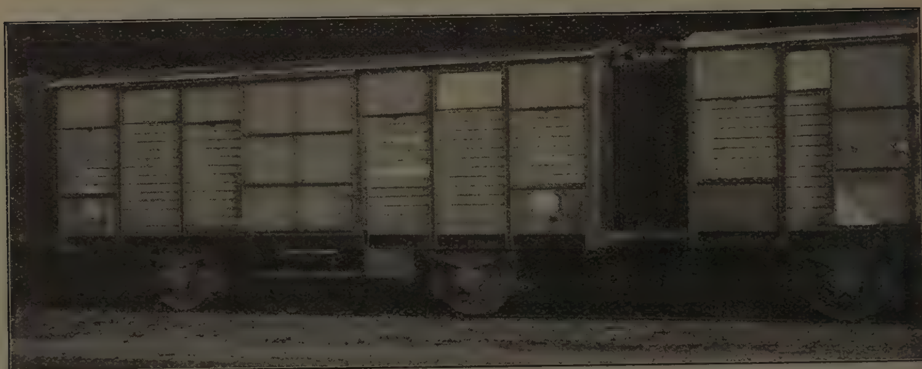


Fig. 10. — Wagons connected by a vestibule, used for the transport of parcels by the « Rapidi colettame », trains, Italian State Railways.

Verona, Verona-Bologna, and Milan-Bologna (in all 3 028 train-kilometres = 1 869 train-miles) is provided by 300 wagons only, including spare wagons to replace damaged wagons.

Thus, with these 300 wagons, a service is provided which formerly necessitated about 700 wagons, and this difference is explained as being due to the high average speed of these new trains which is almost three times that of the old pick-up trains, and to the abolition of numerous normal wagons for picking up and setting down parcels which used to run

in the pick-up trains that have been abolished.

In addition to increasing the rapidity of transport, a saving in stock and haulage costs has therefore been effected, by the reduction in dead weight hauled. Statistics relating to the loading of goods in detail carried by the trains in question show that this loading varies from 4 tot 5 t. per wagon and is thus greater than the average load carried in parcels wagons running in the other trains.

For the transport of fast parcels on the lines on which the *treni rapidi collettame* are run, the previously existing organisation has been retained as far as long-distance traffic is concerned. As regards short distance traffic, the *treni rapidi collettame* are also used for this traffic, so as to provide the fast traffic with a larger number of and more frequent means of forwarding goods.

As has also been found on the German Railways, it is an incontestable fact that, due to the transport of slow parcels having been appreciably speeded up on the lines served by the *treni rapidi collettame,* some of the short distance consignments which were previously carried by fast trains have passed to the slow trains, which is a financial loss to the railway, but this loss may be made good by the recovery to the advantage of the railway of the traffic which the motor had previously taken from it, a recovery which in time may even convert the loss into a profit.

However this may be, it is too early to pass a final opinion on this question, as far as the Italian Railways are concerned, considering that the innovation is still in its infancy, and that the investigations and statistical researches are still being carried out.

Our enquiry has shown that fast light trains for transporting parcels over short distances have also been introduced on the Austrian, Czechoslovakian and Rumanian Railways. On the Czechoslovakian State Railways, « Leig » trains are run on most of the main lines. They have a running speed of 60 to 70 km. (37 to 43.5 miles) and a average speed of 22 to 30 km. (13.6 to 18.6 miles).

CHAPTER V.

Transhipment of parcels. Utilisation and choice of fixed transhipping plant.

1. Transhipment during the journey. — Generally, the transhipment of parcels from wagon to wagon is effected in definite tranship stations provided with the necessary plant.

On some railways, transhipment from wagon to wagon is effected while the collection and distribution parcels train is stopped in certain intermediate stations which are best suited for this work.

On the main lines of the Italian State Railways, the trains carrying fast parcels comprise in their formation a group of wagons communicating with one another by vestibuled gangways, and are provided with a crew of transhippers who, while the train is running and during the stops in the intermediate stations, with the assistance of the station staff, arrange the packages in groups in order to facilitate unloading, and effect transhipment from wagon to wagon, such that, on arrival at the most important exchange stations or at the terminus station for the train, the goods have already been assembled according to destination in separate wagons, which pass into the connecting trains to be conveyed in the various directions. This service is regulated by a precise and detailed programme for the work of transhipment which the crew of each train are bound to carry out.

On some lines, this transhipment service is likewise carried out for slow parcels, by the staff accompanying the

train, but only during the stops in intermediate stations, the wagons not being intercommunicating. This special transhipment service is only employed on certain lines on which the following advantages may be procured :

a) possibility of effecting transhipment while running (with intercommunicating wagons), or in intermediate stations in which the train is obliged to stop for other requirements of the service, and consequently without prolonging the time of the run ;

b) abolition of transhipment and holding up of goods in exchange stations or termini, by passing parcels directly from one train to another train connecting with it, resulting in more rapid forwarding of goods ;

c) in certain cases, reduction in the number of wagons in circulation.

For the work under consideration, special bonuses are granted to the men of the gangs. These bonuses are based on the importance and conditions of the transhipping work performed. The remuneration is calculated according to the weight of goods transhipped and the type of wagons loaded (wagons carrying goods for a single destination more than 100 km. (62 miles) distant and wagons for a tranship station more than 300 km. (186 miles) from the station in which these wagons are taken from the train to continue by other and more rapid trains.

II. *Tranship stations.* — By tranship station is understood not an unimportant exchange station where from time to time packages are unloaded from a wagon to be loaded into others, but important centres where normally numerous wagons arrive with parcels, the transhipment of which into other wagons is systematically organised.

The number and distribution of the « tranship centres » vary from one railway to another according to the extent and configuration of the system, the intensity and direction of the streams of traffic and the principles adopted in organising the tranship service.

On the large railways, where there are veritable fast goods sorting centres, work is carried out so to speak everywhere by day and night, and even on Sundays and holidays.

On almost all railways, in the large slow goods tranship centres work is done generally by day, the working hours being extended if necessary from the early hours of the morning to the late hours of the evening. It is only in special cases that night services are also organised for transhipment.

Sunday and holidays are also worked on :

a) the Italian and Bulgarian State Railways ;

b) the German Reichsbahn, but only in urgent cases, and during periods of intense traffic peculiar to the seasons ;

c) the Yugoslavian State Railways, but only in seven important tranship centres, where the work is carried out without interruption for 24 hours ;

d) the Czechoslovakian State Railways, but only in some of the more important tranship centres ;

e) the Egyptian Railways, occasionally in case of necessity.

Night work and prolonged day work speed up transport considerably, but are inadvisable from the standpoint of economy; night work in particular is less regular and less productive. Hence, in this question, each administration will decide what is best suited for it according to local traffic conditions and the particular requirements of its service.

As a general rule, the work of transhipment is carried out by the staff of the railway administration.

On the Italian Railways, in the most important centres, and on the Yugoslavian Railways in some of these centres

only, the handling of packages is entrusted to private undertakings under the direction and supervision of the railway employees. In some important stations of the Italian State Railways, the private undertaking is likewise authorised to do the booking and to direct the foremen, while the general direction and supervision of the work are left to the stationmasters and the foremen in charge of the tranship platforms.

On the German Reichsbahn and on the Czechoslovakian and Bulgarian Railways, this work is carried out exclusively by the railway staff.

The transhipment staff is divided into gangs composed of a foreman and three or four men. There are also specialised employees for distributing the documents, affixing the lead seals and labels on the wagons, driving the motor trolleys, etc.

The Italian State Railways grant special bonuses to the railway employees who work on transhipping for the rapid handling of packages and the best formation of wagons, while observing the rules mentioned above for transhipment effected during running of the trains.

On the other railways that have replied to our questionnaire, special bonuses are not granted. On the Reichsbahn, the work is done by the job in the large tranship centres, and the payment is calculated on the basis of the time allowed for a man to handle one ton of packages. The surplus is divided among all the men and is added to the normal pay fixed on the above-mentioned basis. Extra pay, varying from 60 to 100 % of the surplus job pay received by the men is granted to certain classes of staff (load sorters, motor trolley drivers, labellers, document sorters, etc.).

The traffic of fast parcels, being of limited importance, does not necessitate special tranship plant, apart from the departure and arrival sheds.

The traffic of slow parcels, on the contrary, which comprises the greater part of parcels consignments requires, on the large railway systems, tranship plant specially adapted for providing rapid handling of packages and satisfactory marshalling of the wagons.

In stations of average traffic, local and in transit, it may be an advantage to combine the tranship plant with the local warehouses, because in this case the goods which are for departure may be loaded up with goods in transit, thus securing a better formation and utilisation of wagons, while the local goods may be unloaded directly at the arrival warehouse.

The following types of plant would appear to be well adapted to the purpose :

I. *Tranship plant combined with departure warehouse :*

a) Tranship platform adjacent to the acceptance platform ;

b) Tranship platform between two acceptance platforms ;

c) Acceptance platforms facing one another and between them the road giving access to the lorries and carts bringing the goods for departure. The two platforms are connected at one end by a large transverse platform, at which the tranship platforms terminate like the teeth of a comb.

II. *Tranship plant combined with the departure and arrival warehouses :*

a) Tranship platforms in the middle of the departure and arrival sheds. Along the two outer sides of the plant, the road giving access to the warehouses for bringing goods for departure and removing those which arrive.

b) Arrival and departure warehouses situated one after another in a line and skirted by the tranship platform.

In stations in which large quantities of goods for different directions are concentrated and which are not important centres of local traffic, it may be more advantageous to have the tranship plant separate from that for the local traffic.

The platforms communicate with each other by means of a transverse platform or by means of movable bridges (lifting or sliding).

A few examples of the most up-to-date plant will be given :

Cologne Kalk Nord (Germany). — Length 400 m. (1 310 feet), width 76 m. (250 feet). Four through tracks, six dead-end sidings which enter by one end, and six other dead-end sidings entering by the other end up to about a third of the total length of the plant. There is room for 160 loaded wagons and 140 empties. Each day about 400 wagons are handled.

Wahren. — Length, 328 m. (1 076 feet), width, 63 m. (207 feet); room for 237 wagons. The plant is situated in the middle of the shunting yard and is covered by a large roof. Six loading platforms and 7 tracks, all of which are through tracks. About 500 wagons are handled.

Milan marshalling yard. — Length, 210 m. (689 feet), width 70 m. (230 feet). Five tranship platforms with 9 through tracks (two tracks between one platform and the next), in a large shed of reinforced concrete with roof and skylights. Room for 220 wagons. The tranship platforms communicate with each other by means of sliding gangways situated in the middle of the length of the platforms (figs. 11, 12, 13 and 14).

The most rational and modern of tranship plants are provided with electric light, the lamps being suitably distributed along the tranship platforms and points or sockets being provided for portable lamps for lighting the interior of wagons. These sockets may be provided on the columns supporting the roof covering the platforms, on the walls or under the floor.

In almost all the installations of the Italian State Railways, such sockets are provided on the columns of the tranship platforms. The Reichsbahn prefers the method of obtaining current by means of a double copper wire extending the entire length of the tranship platform, a sliding rod carrying the lamp with its cable being suspended from the copper wire.

The tranship systems vary with the arrangement, operating means, importance and function of the plant. The best would be that consisting in emptying all wagons as they arrive, depositing the goods on the tranship platform and grouping them by destinations, and afterwards loading them into empty wagons conveniently placed for forming the departure wagons in accordance with a fixed programme for forwarding goods and forming trains.

This system permits goods wagons to be made up under the best conditions from the point of view of regular loading, utilisation of stock and delivery of goods, but it gives rise to considerable handling costs (unloading and reloading), a greater use of stock in providing empties, extensive platform and track installations, and to an increase in the length of time taken in handling the goods.

The most practical and economical system which is generally adopted in important centres is to tranship the goods directly from the wagons arriving into the wagons for departure, the only goods set down on the platforms being those for which room cannot be found at once in the departure wagons. In less important tranship centres, and in those which are not provided with the necessary tranship plant, it may be more profitable no to unload the goods completely from the wagons on arrival and to leave in the wagons those consignments whose weight, nature and destination render it preferable that they should continue their journey in the same wagon, into which other goods for the same destination are subsequently loaded.

This system, however, cannot always

Fig. 11. — Tranship centre in Milan marshalling yard.

Fig. 12. — Tranship installation in Milan marshalling yard.

Fig. 13.

Fig. 14.

Figs. 13 and 14. — Tranship centre in Milan marshalling yard between tranship. Traverser between transhipment platforms.

be based on a fixed programme for the formation of wagons, but necessitates each day a very close preliminary examination of the quantity and destination of the goods contained in the wagons arriving so as to be able to draw up the tranship and formation programme for the departure wagons, a programme

which consequently may vary from one day to another.

The wagons arriving at tranship centres generally contain goods for all the directions relating to the function allotted to these centres. This facilitates the operations necessary for bringing the wagons to the tranship platforms, since in such case there is no preliminary shunting of the wagons.

With a view to speeding up the work of tranship by reducing the distance travelled by goods on the platforms in passing from one wagon to another, it may be advisable in certain cases of heavy movements of traffic for definite directions, to bring to the tranship centre wagons containing only goods for these destinations, and to specialise suitable transhipping platforms for this purpose.

The organisation of the work of tranship should aim at grouping the goods so that they arrive at their destination as rapidly as possible, while avoiding subsequent transhipment.

Consequently, wagons of parcels should be made up in the following order of priority :

a) Wagons containing goods for one destination ;

b) Wagons containing goods for several localities situated on the same line or section of line ;

c) Wagons containing goods which are to undergo another handling in another tranship centre.

Wagons of parcels are brought to the tranship platforms and are removed from them several times daily, according to the importance of the work, the capacity of the plant, the tranship programme and the working shifts, profiting as far as possible by the rest periods of the staff. From the point of view of the best utilisation of stock, it would be preferable to leave the wagons under load as long as possible, but on the other hand, from the point of view of forwarding goods rapidly, it may be of greater advantage, particularly in large tranship centres, to and from which arrive and depart numerous trains, to effect the operation of exchanging the wagons more frequently, even at the sacrifice to some extent of satisfactory utilisation of stock.

Consequently, the method of working varies from one locality to another. As a general rule, an endeavour is made to effect as far as possible a compromise between rapid delivery of goods and satisfactory utilisation of stock.

In tranship centres combined with the local departure warehouse, it is preferable to wait until the acceptance windows are closed before removing the wagons.

In large tranship centres, there is considerable advantage in adopting the method of fixing the position of the wagons under load according to a definite and invariable programme, so that the wagons will be ready grouped for inclusion in their departure train without the necessity of sending them to the shunting and marshalling sidings, to be shunted and sorted. This simplification contributes largely to the rapid departure of the wagons.

This system is applied in the large transhipping stations of the German Reichsbahn and in some important tranship centres on the Italian Railways.

The Czechoslovakian State Railways are considering the formation of new tranship stations in which the abovementioned system will be adopted.

The methods carrying out the work of transhipment depend upon the system adopted. If the system of a fixed and predetermined programme for making up wagons is adopted, each wagon, according to the place it occupies at the tranship platform, will receive goods intended for a certain station or zone. The wagon is provided with a pre-arranged number corresponding to the destination of the load.

If, on the contrary, the programme for

making up the wagons is not fixed and predetermined, the work of transhipment is preceded by a preliminary examination of the transport documents, and this examination serves as a basis for determining each day the types of wagons which may be made up, taking the quantity and destination of the goods into consideration.

With the fixed programme, the work of transhipment proceeds rapidly and easily, and it is preferable to adopt it in tranship centres, in which there is a very considerable amount of traffic in transit and where a certain constancy to be observed in the directions of the consignments, thus ensuring rational utilisation of stock. Of course, such a fixed programme may be subject to modifications in the course of the year, and is supplemented daily by an additional programme which varies according to the needs of the day.

With the variable programme, the work of transhipment is longer and more complicated, and hence less economical and slower, but it adapts itself better to daily fluctuations in traffic and enables the stock to be utilised better. It is preferable to adopt this system in less important tranship centres where the streams of traffic are not constant.

The delays to which slow parcels are subjected in the tranship centre, from the moment they arrive at the station to their departure, depend upon the size, situation and arrangement of the plant, the duration of the working shifts, the frequency of the trains arriving and leaving, and the system adopted for the programme of work. The goods arriving by morning trains generally depart during the course of the day. Those arriving by the evening or night trains are, if night work is not done, subjected to a longer delay according to the time elapsing before day work commences.

In order to reduce appreciably the length of stay of goods in tranship centres, the working period ought in general to be extended to cover the 24 hours of the day. This measure, however, is only applicable in special cases when it becomes expedient and profitable, because in general night work is not only more expensive but is less regular and less productive than day work.

The delay of fast parcels in stations where they are to be transhipped is very short because in general such goods are valuable or very perishable, and are sent on by connecting trains at all hours, even during the night.

From both the technical and economic points of view, it is desirable that large tranship centres should, as far as possible, be installed in stations having a considerable transit parcels traffic, and where at the same time the trains are split up, in order to secure satisfactory formation of the wagons and their prompt departure by the most suitable long or short-distance train. The tranship plant should therefore be situated so as to facilitate and speed up the operations of bringing in and taking out the wagons. Preferably, therefore, is should be situated between the splitting up sidings and the marshalling sidings.

A satisfactory parcels service necessitates a well planned organisation for the tranship centres. The most suitable localities for carrying out the work of transhipment and the necessary operating means should be carefully selected, and the programme to be assigned to each tranship centre should be drawn up with care, so as to obtain the best results from the point of view of economy and of rapid delivery of goods.

CHAPTER VI.

Unloading parcels. — Arrival advices.

Generally, intermediate stations unload their parcels while the trains stop at them. Therefore the collection and distribution trains of parcels are allowed a length of stop in these stations corres-

ponding to the average traffic in each station. On lines where the traffic is heavy, in order to avoid excessively long stops, it is preferable to increase sufficiently the staff travelling with the train and, on the passage of the trains through intermediate stations, to assemble as large a number of workers as possible.

As a general rule, intermediate stations are not authorised to retain wagons of parcels in order to unload and load their goods and to send on the wagons later by another train, the purpose of this regulation being to avoid delaying the despatch of the goods remaining in the wagon. On some railways, it is permissible to keep back wagons of slow parcels when they contain a large number of consignments for an intermediate station and to unload them would delay the train appreciably, or when the wagon contains many goods for two stations only.

Unloading by night is generally avoided in terminus stations as being too expensive, safe in the case of exceptional traffic in periods varying with the seasons, when the object is to avoid overcrowding and operating difficulties, care being taken however to begin in the early hours of the morning so as to deliver the goods in the hands of the consignees before noon. One railway even unloads on Sundays and holidays.

One some railways, unloading of goods in the warehouses of the destination stations of the wagons is effected exclusively according to the way-bills. On others it is done on the basis of the loading docket accompanying the wagon. On the Italian State Railways, it generally takes place in accordance with the way-bills, and in large stations special lists are drawn up of packages for unloading.

The system of unloading on the basis of the loading dockets accompanying the wagon or of special lists of packages for unloading affords the advantage of making loading and fixing the charges independent and simultaneous, and consequently of speeding up the release of the goods.

Generally, consignees are advised of the arrival of consignments by telephone, by post or by an employee specially appointed for the purpose. Advice by telephone is obviously the quickest, but in practice it can only be adopted in certain localities and for important firms. Advice by post is simpler but not so quick. The system of sending the advice by a special employee fulfils its object satisfactorily in practice in most localities of intense and average traffic.

With the object of speeding up the removal of goods by the consignees, the arrival advices should be drawn up several times daily and sent to the consignees by quickest possible method.

In the large stations of the German Reichsbahn, the way-bills for goods arriving are sent to the charge computing offices by pneumatic post. The computing of the charges is facilitated by the use of plates prepared beforehand, with the tariff bases as previously described in discussing the goods for departure. The account note for payment is prepared at the same time as the arrival advice by means of typewriting and calculating machines.

In the case of exceptional traffic, and with a view to preventing overcrowding of the warehouses, the Italian State Railways may reduce the period allowed by the tariffs for the removal of goods. This period is 24 hours if the advice is sent by special employee and 36 hours if it is send by post.

The German Reichsbahn makes an extensive use of the power conferred upon it by law of delivering goods to the door, this service being entrusted, in large and average stations, to private door-to-door transport undertakings according to rates fixed by the railway. The latter is responsible to the public for losses, damages and delays ascribable to the undertaking, the railway recoup-

ing itself against the undertaking by the terms of the conditions of the contract.

On the Italian State Railways, likewise, there is a similar system of delivering goods to the door in stations of intense and average traffic. Such delivery, however, only takes place if the consignor applies for it on the way-bill, except in special cases of delivery to the door by virtue of the tariff provisions.

On the Czechoslovakian State Railways, delivery to the door is only effected by the railway at a few important stations, and at the request of the consignor.

CHAPTER VII.

Control of the transport of parcels.

The transport of parcels should be under constant supervision and control with a view to ensuring proper application of the programmes and special instructions concerning the loading, unloading and transhipment of the goods, and with a view to discovering systematic causes for delay to goods, which must be remedied by suitable measures and modifications in organisation, so as to make the service more and more rapid and economical.

It is necessary to examine in particular whether the deviation of traffic by the means of transport in competition with the railway has been due to the length of time taken by transport or to other causes and, by remaining in contact with the affected centres of industry and commerce, to endeavour to ascertain in good time the desires and hopes of the consignors in order to regain for the railway the traffic connections which have been lost, and if possible to procure fresh traffic.

In the more important railway administrations, the above-mentioned control is organised under satisfactory conditions and is exercised by specialised officials attached to the management of the central and regional offices.

CHAPTER VIII.

Mechanical and electrical appliances for handling parcels.

The German Reichsbahn employs mechanical and electrical appliances for this purpose.

I. *Mechanical appliances.*

a) *Hand trucks* of different types, sometimes provided with ball-bearing wheels (fig. 15).

b) *Boards* of trapezoidal shape, fitted to the ends of hand trucks to increase their loading capacity for ponderous and bulky goods which cannot be carried on a hand truck alone (fig. 15).

c) *Containers* with four loose wheels (of which two are adapted to be fixed by a mechanical locking device when they are pulled by hand or hauled by motor trolley). Dimensions : 1.10 m. × 2 m. (3 feet 7 5/16 in. × 6 ft 6 3/4 in.). Load 2 tons (fig. 1).

d) *Loading trays.* — Loading trays which may or may not be provided with movable ends and sides but are provided with fixed or movable castors which are locked on touching the ground and are moved by lifting trucks (fig. 16). Dimensions : 0.90 m. × 1.50 m. (2 ft. 11 1/2 in. × 4 ft. 11 in.). Load : 2 t.

e) *Lifting motor trolleys.* — For carrying the loading trays which are removed from the lifting platform of the trolley by means of a lever device and are set down automatically and slowly by the action of a brake, after releasing the stop catch. Load 2 tons (fig. 17).

The hand trucks are used everywhere and are employed more particularly for carrying goods over short distances.

The containers and loading flats are utilised daily on certain traffic routes, for which according to statistical data they are employed normally as much as possible both on the forward journey and

Fig. 15. — Hand trucks fitted with ball-bearing wheels and provided with boards to increase their loading capacity.

Fig. 16. — Loading tray.

Fig. 17. — Lifting trolley.

Fig. 18. — Electric tractor with trailer.

on the return journey. The containers are provided with an indication of the route which must be adhered to absolutely.

II. *Electrical appliances.*

a) *Electric trolleys* (with loading platform). — Load : 750 to 1 500 kgr. (1 650 to 3 300 lb.). Loading platform : 1 m. × 1.80 m. (3 ft. 3 3/8 in. × 5 ft. 11 in.) or 1.05 m. × 2 m. (3 ft. 3 9/32 in. × 6 ft. 6 3/4 in). Height of loading platform above the ground : 53 cm. (20 7/8 inches). Two motors on the back axle, driven by accumulators. Can be used for carrying a load themselves and also for hauling trailers loaded with goods. Weight transported : 1 600 to 3 000 kgr. (4 520 to 6 600 lb.). Work performed : 32 t. in 9 hours, with motor trolleys loading 750 kgr. (1 650 lb.) (fig. 18).

b) *Electric tractors* (without loading platform). — Are used for hauling loaded trailers. Work performed : 50 tons in 9 hours. Maximum weight transported on each trip : 3 tons. Are more suitable for transporting heavy packages.

c) *Trailers for motor trolleys.* — Load : 3 tons. Height of loading platform : 30 cm. (11 13/16 in.) The motor trolleys are also capable of entering the wagons and moving through them.

On the Czechoslovakian State Railways, use is made of :

a) different types of hand trucks;

b) motor trolleys (petrol and accumulator);

c) loading trays for transporting goods which are left in the wagons until the unloading station is reached.

The hand trucks are used for short distances. For long distances and particularly in tranship stations, the abovementioned motor trolleys are employed, with which it is also possible to enter the wagons and haul trailer trucks.

On the other railways that have replied to our questionnaire, loading, unloading and transhipping goods in detail are effected by means of hand trucks of different types and sizes.

The use of mechanical and electrical appliances is useful for the delivery of goods, because it speeds up loading, unloading and transhipping appreciably, particularly in stations of intense traffic where considerable quantities of parcels are handled and moved daily. In this case, however; it is essential to provide warehouses and platforms suitable for running motor trolleys.

According to calculations made by the German Railways, the first cost and maintenance costs of the appliances previously mentioned is amply repaid by the considerable saving in the staff employed in handling goods.

On the Italian State Railways, the use of motor trolleys and loading trays is under test in a large tranship station.

In some tranship stations of lesser importance on the Italian Railways, good results have been obtained with the use of a tranship wagon running on a track situated between two other tracks, on which stand the wagons containing the parcels to be transhipped from wagon to wagon (fig. 19).

The floor of the tranship wagon is on a level with those of the wagons under load and has an area of 32 m². The wagon is electrically lighted having lighting points for the interior of the wagons : it is covered in and has end partitions.

In order to tranship packages, they are placed in the tranship wagon, which is then run along its own track between the two rows of wagons to be loaded.

By this means, the installation of a fixed tranship plant in stations of lesser importance is economised, while the amount of work done is the same. Two or three of these tranship wagons are in service in several localities.

In the tranship station of Capua, where 40 wagons of parcels are transhipped daily, a special type of tranship platform has been put down for trial. This plat-

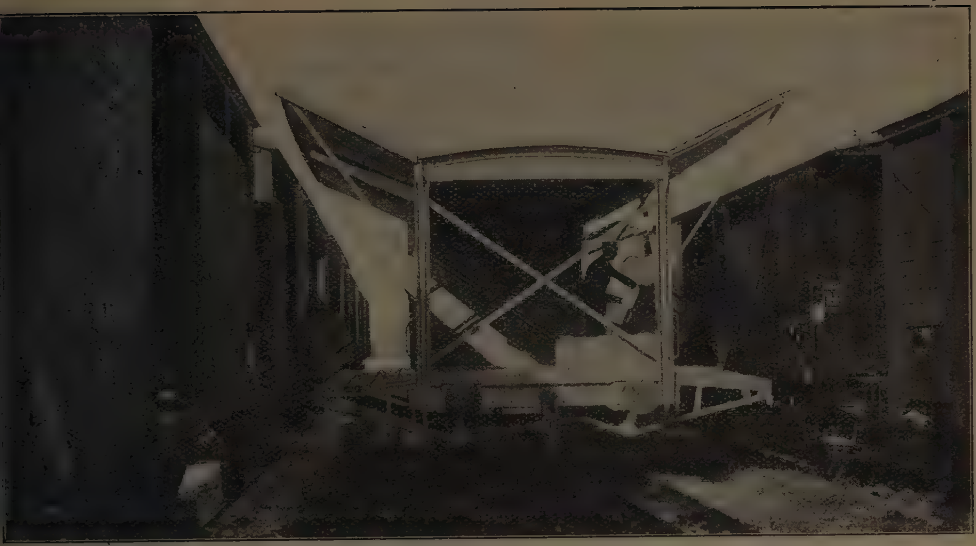


Fig. 19. — Tranship wagon, Italian State Railways.

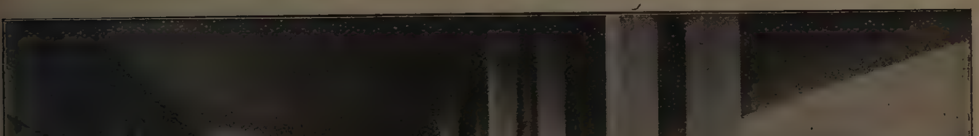


Fig. 20. — Tranship station at Capua.

form has a height of 60 cm. (23 5/8 inches) above the ground, with an asphalt floor and a roof of reinforced concrete, and on the platform small hand-drawn trolleys run on small tracks of 2-foot gauge. These trolleys move lengthwise and crosswise by means of double sets of lines and enable packages to be removed from one wagon to another quickly (fig. 20).

The wagons which are to be transhipped are arranged on two parallel tracks running along the tranship platform, and the floor of the small trolley, [1.80 × 0.95 m. (5 ft. 11 in. × 3 ft. 1 3/8 in.)], is on a level with the floor of the wagons. This system has given good results and may be adopted advantageously in small tranship centres.

Summary.

The organisation of the transport of parcels calls for a close and incessant study of the currents of this traffic and the use of the most effective measures for grouping and distributing consignments, so as to ensure regular and rapid transport without losing sight of the rational and economical utilisation of plant, stock and personnel.

During recent years, every railway administration has felt more and more intensely the need for improving its organisation so as to provide transport which shall be as rapid as possible, this with a view to meeting the competition of the motor lorry and to satisfying the requirements of commerce which, in the present economic situation, tends to reduce the stocks of goods so as to avoid locking up large sums of capital, a tendency which necessitates small, frequent and rapid supplies.

The organisation of parcel transport cannot be uniform on all railways, seeing that traffic conditions vary with the extent, configuration and importance of each railway system.

Nevertheless, almost all administrations apply the following fundamental principle :

In the stations of origin of consignments and in tranship centres, efforts are made to assemble the goods so as to form above all the largest possible number of wagons with goods intended for a single station, because in this way, the goods will proceed directly and rapidly to their final destination without undergoing any transhipment. In the second place, wagons are made up with goods intended for a suitably selected tranship centre or unloading zone so as to reduce as far as possible the number of transhipments during the journey.

The organisation set up will be a good one when the number of transhipments does not exceed on the average two.

Under the present general economic conditions, the new demands of commerce and the competition of the motor render maximum speed of delivery imperative, even though this should result in a diminution in the weight of goods carried in each wagon, a diminution which ultimately does not involve a greater use of the rolling stock allotted to the transport of parcels, since the increase in the speed of circulation of these wagons enables them to be used over again to a greater extent, that is to say, the interval between two successive loads is shorter.

On most railways, the minimum regulation weight for making up complete wagons of parcels is not greater than 1 500 kgr. (3 300 lb.) for fast traffic and 2 000 kgr. (4 400 lb.) for slow traffic. In special competitive cases, or of wagons intended for ports, these minimum weights are often reduced to some extent.

The delivery of goods and the meeting of motor lorry competition may be favourable affected by a well-organised service for the collection and delivery of parcels consignments from and to consignors and consignees, with frequent and inexpensive means of transport. This service is provided by private under-

takings who are entrusted with it by the railway administration under contract and at rates and conditions made known to the public.

Direct loading of packages into the wagons affords the advantage of obviating handling of the goods in the warehouse and may be useful in exceptional cases of large consignments or appreciable quantities of goods for certain destinations when the nature of the goods permits the operation of weighing to be dispensed with, or when this operation may be done in the destination station, and when the wagon may be conveniently utilised and prepared promptly for departure by the scheduled train. In periods of more intense traffic, it may form an effective auxiliary means of avoiding overcrowding of warehouses and the latter's harmful repercussion on the delivery of consignments.

Consignments of parcels are generally accepted every day (except on Sundays and holidays, for slow traffic) and for all destinations, so as to meet the requirements of commerce in the best possible way. During days or periods of heavy traffic, it may be expedient to extend the hours for accepting and delivering consignments.

Labelling of packages is preferable when done by the consignor himself for reasons of saving in time and labour. When done by the railway, labelling is more expensive, but is a better guarantee of the regular forwarding of the consignments.

To simplify and speed up the operations of weighing and computing the charges for parcels consignments in large stations having a heavy traffic, it may be expedient to employ large numbers of weighing machines, preferably automatic, placed at the most suitable points of the goods acceptance room. It may also be advantageous to adopt the mechanical system of computing charges employed in several large stations on the German Reichsbahn.

The warehouses where the parcels are accepted should be sufficiently spacious, easy of access to the public, and should be in a situation suitably selected so as to facilitate the operations of bringing the wagons in and out and grouping the goods by destinations. It should be possible to effect unloading of private vehicles and loading into the railway wagons easily, rapidly and regularly. The employees in charge of the booking and loading of goods should have a perfect knowledge of the routes and traffic, so as to prepare a proper grouping of the packages before their loading.

To speed up the delivery of consignments, a good rule is that of « *loading by day and travelling by night* » on lines where this method of working is compatible with the operating conditions and where it does not result in excessive expenditure.

Efforts should be made to despatch goods on the same day as their acceptance. However, the time elapsing between acceptance and departure, should be that which is necessary and sufficient to ensure that the goods are handled with care and are loaded regularly and expediently from the point of view of rapid delivery and also of the satisfactory utilisation of stock.

Special labels affixed to wagons of parcels contribute to the regularity and rapidity of the operations of loading, unloading and shunting.

A good rule requires that complete wagons of parcels should be given priority of despatch over wagons containing complete load consignments.

In periods of intense traffic, the various railway administrations generally take special steps to avoid overcrowding in warehouses and delay in despatching goods (increasing the staff, extension of working hours, Sunday and night work, increasing warehouse charges, reducing

the length of time allowed for removal of goods by the consignees, etc.).

It is expedient to resort to indirect routes when the diversion of goods on to lines which are more important or are more advantageous for the trains conveying the goods has the effect of speeding up the transport.

The service of loading, unloading and transhipping packages may be advantageously entrusted to private undertakings in centres of average and intense traffic from the point of view of economy and rapidity of transport, particularly where there are periodical increases of traffic according to the seasons, because a private undertaking is more easily able to procure labour corresponding to the fluctuations of traffic.

The use of containers for grouping consignments intended for one or more stations is advantageous from the point of view of protecting the goods, saving of labour in handling the goods, and rapidity of the operations of loading and unloading.

With the object of effecting rapid arrival of consignments of parcels coming from different lines or of forwarding rapidly consignments intended for different lines, it may be expedient to employ motor lorries on the road for conveying packages from one station to another or from one office to another in the same locality.

Complete wagons of parcels which do not require any handling during the journey (local wagons, tranship wagons, wagons for a definite unloading zone) ought to be forwarded to their final destination, or to the tranship centre, or to the beginning of the unloading zone, by the most suitable goods trains having a high average speed and preferably running during the night hours. The wagons for collecting and distributing goods in intermediate stations are conveyed in general by local pick-up trains, which latter are also utilised for complete load wagons, empties and shunting. The service provided by long and heavy, slow-running trains is now considered to be obsolete. It has been found that it fails to meet present requirements of the parcels traffic and that it is much slower than that provided by motor lorries on the road, particularly for short-distance consignments. The necessity for adopting measures adapted to remedy this situation has therefore become imperative.

With this in view, the Reichsbahn, and the Italian, Czechoslovakian, Austrian and Rumanian State Railways, on important lines, run special rapid and light trains. Travelling speed: 60 to 70 km. (37.3 to 43.5 miles) average speed : 20 to 30 km. (12.4 to 18.6 miles) for collecting and distributing short distance parcels.

This organisation, which is still in the experimental stage, has already given good results, and it is conjectured that it will be developed and improved.

For the transport of fast parcels, passenger trains of less importance are also used on lines which are not served by special express trains for fast goods.

A good rule is to place the wagons of parcels so that they will be together in one part of the train, in order to facilitate handling of the goods in intermediate stations, to avoid as far as possible these wagons passing through the shunting sidings of the destination stations and to allow them to arrive directly and rapidly at the unloading and transhipping platforms.

The booking of consignments on special loading dockets which accompany the wagons and in the books which are used in handing over the goods as between the train staff and the station staff ought to be reduced to the indispensable minimum with a view to saving time and money.

The number and distribution of the « tranship centres » vary from one railway to another according to the extent and configuration of the railway system, the intensity and direction of the streams of traffic and the principles adopted for the organisation of the tranship service.

It is necessary to choose with care the most suitable localities, to decide upon the necessary plant and auxiliary appliances and to draw up the programmes to be allotted to each tranship centre, so that sorting and grouping of the goods shall be effected in a way such that they will arrive at their destination as quickly as possible and subsequent transhipments will be avoided or reduced to the smallest possible number.

On the large railways where there are veritable fast traffic tranship centres, the work is done almost everywhere by day and night and even on Sundays and holidays. On the contrary, in slow traffic tranship centres, work is only done in general during the day, the working shifts extending, where necessary, from the early hours of the morning to the late hours of the evening.

Tranship work done at night speeds up the transport but is expensive, less regular and less productive than day work. Every railway should therefore decide this question by taking into consideration the advantages and disadvantages, the local conditions and the particular requirements of its service.

With a view to obtaining rapid handling of packages, some railways grant special bonuses or gratuities, based on the production and quality of the work done, to the employees appointed to do this work.

In stations with average local and through traffic, there may be advantage in combining the tranship plants with the local warehouses. In fact, in this way, it is possible to load goods for despatch with goods in transit, so as to make up and utilise the wagons better and to unload local goods directly in the arrival shed.

On the contrary, in stations where large quantities of consignments in transit for different directions are concentrated, it may be preferable to have tranship plant separate from that of the local traffic and generally formed of several parallel platforms, with one or more tracks passing between them. These tracks are preferably connected at both ends to the splitting-up sidings so as to render the operations of bringing in and removing the wagons easy and rapid.

The most rational and most modern lighting is electric lighting with lamps and electric light points enabling the wagons to be lit up by portable lamps.

The most rapid and economical system, use of which is recommended in the more important centres, is to tranship directly from arrival wagons into departure wagons according to a fixed and predetermined programme, only those goods which cannot be placed immediately in the departure wagons being set down on the platforms. In less important tranship centres not provided with suitable plant, it may, on the contrary, become more advantageous to avoid completely unloading goods from wagons which arrive, leaving in these wagons those consignments whose weight, nature and destination render it preferable for them to continue their journey in the same wagon which is subsequently loaded with other goods for the same destination.

In large tranship centres, it is very useful to fix the position of the wagons under load according to a definite and invariable programme, so that these wagons will be already grouped for inclusion in their departure train without it being necessary to send them to the shunting yard to be sorted and marshalled. This simplification in shunting contributes greatly to the rapid departure of the wagons.

The large tranship centres should be installed as far as possible in stations having a heavy transit parcels traffic and serving also marshalling yards, in order to obtain at the same time a satisfactory formation for the wagons and their rapid departure by the most suitable trains.

The system of unloading packages on

arrival, which is based on the lading bills accompanying the wagon or special unloading dockets, affords the advantage of rendering independent and simultaneous the operations of unloading, and those of computing the charges and sending the arrival advices to the consignees, and hence speeds up the release of the consignments.

The arrival advices should be made out several times daily and sent to the consignees by the quickest way.

The use of mechanical and electrical appliances for handling parcels appreciably speeds up the operations of loading, unloading and transhipment. Such use is more particularly advisable in large tranship plants where considerable quantities of packages are handled and moved daily.

[625. 144.4 & 625. 17]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

XIIth SESSION (CAIRO, 1933).

QUESTION II:

The use of mechanical appliances in the permanent way maintenance and in track relaying.

REPORT No 1

(United States of America, Great Britain, Dominions and Colonies, China and Japan),

by F. M. THOMSON,
District Engineer, Missouri-Kansas-Texas Lines, Parsons, Kansas.

In assembling data for this report on Subject No. II : « The use of mechanical appliances in the permanent way maintenance and in track relaying », a joint questionnaire was distributed by the Permanent Commission to the various railway members of the International Railway Congress Association.

The replies to this questionnaire together with other data available to your reporter from the American Railway Engineering Association, the individual railways themselves, and other reliable sources have been used as a basis for reporting on North America, Great Britain, Dominions and Colonies, China and Japan, as assigned.

North America.

In the United States of America and in Canada, mechanical appliances have been used extensively, and their use has resulted in securing greater efficiency and larger economies. In fact, track maintenance has been rapidly developing beyond the hand labor stage and now requires the aid of the best and most modern mechanical equipment and devices for successful operation. The class of work done by mechanical appliances, as a rule, compares favorably with that done by hand labor, — often it is of a better grade and more lasting.

In order to keep pace with the greater speed and the heavier traffic requirements, the railways have improved their maintenance standards by adopting heavier and better materials in their track construction. This has promoted a tendency towards the further use of mechanical appliances in order to facilitate the work, as well as to save labor costs.

These improvements in standard practices and construction materials, with the resulting use of more mechanical appliances, has developed a recent tendency on certain large railways towards a change in gang organization. The development has been on certain railways towards a smaller local section force and an increase in the work done by

extra or floating gangs. The amount of labor required for adequate maintenance of the track and roadway has been reduced through these developments in maintenance of way practices; and, as a consequence, heavy routine work formerly performed by the section gangs, permanently stationed and assigned to comparatively short territories, has been transferred to specialized floating gangs, properly equipped with modern labor saving appliances, with large resulting economies. The natural economic fundamental is to provide adequate maintenance with the least expenditure and with a minimum interference to the operation of the railway. The ample use of labor saving machines and devices carefully selected, efficiently manned, properly supervised and maintained, will help to produce this.

Some of the more important features of construction development are heavier rails, better joints, improved ballast section, treated ties, and the general use of heavier tie plates. These require less frequent attention and replacement than the lighter type of construction formerly in use.

The list of the more important mechanical appliances which have been developed during recent years include such equipment and devices as motor cars, ditchers, spreaders and shapers, cranes and hoists of both locomotive and crawler type, motor trucks, tie tampers, ballast cleaners, discers, track mowers, weed burners, chemical weed-killers, rail laying machines, tie adzers, spike drivers, spike pullers, bolt tighteners, joint beveling machines, etc. A recent canvass of the important railways in the United States and Canada indicates the general use of mechanical equipment and devices during recent years. In fact, every railway canvassed reported the regular use of a large variety of such machines.

Economies in labor saving obtained from mechanical appliances used in the United States and in Canada may not be related in comparison with their use in other countries without first taking into account the varying situations that exist due to the difference in original first costs of the appliances and also the unit cost of work done with hand tools which will vary in each country with the prevailing wage levels, the conditions encountered, and the character of work required. Machines that have proven valuable in these two countries might not be economical when utilized elsewhere. Consequently, a careful study and a test application of each machine should be made before its adoption is definitely recommended for the other countries.

As these improved standards were developed, the formation of specialized extra gangs, trained and equipped for rail laying, ballasting and, in some instances, for heavy tie renewals, became the practice. Further developments have brought and are still bringing changes along this line in gang organization and equipment to handle the work more readily and efficiently. Under this plan of organization for handling maintenance work the personnel of the gang can be specially trained to become more proficient in the performance of their particular assigned duties; and, when they are fully equipped with modern labor saving mechanical appliances, naturally accomplish the same operation, daily, with more efficiency and skill than had they been required to undertake miscellaneous kinds of maintenance work of a varying nature from day to day with hand tool equipment only. Reasonably large gangs are required for an organization of this type in order to secure the maximum efficiency and to warrant the expenditure necessary for a full complement of machines and devices assigned to them for the work at hand.

Below are condensed reports on certain selected railways, showing results

obtained in the use of mechanical appliances in specialized gangs. Except as noted, these are from the findings of the American Railway Engineering Association Committee XXII, « Economics of Railway Labor », of which your reporter is chairman.

Chicago, Milwaukee, St. Paul and Pacific Railroad.

This railway commenced an experiment with large maintenance gangs in 1929. The laborers and supervisor for one gang on a certain roadmaster's division were taken from the local section forces for that division and it was regularly engaged from April to September, inclusive. The average organization included a general foreman, 2 foremen, 2 assistant foremen, 3 machine operators and 86 laborers. During a period of six months, this gang completely rehabilitated about 65 miles of track, including the renewal of about 700 ties per mile, complete resurfacing and final finishing and dressing of ballast and track ditches. The special equipment included track jacking, tie tamping and ballast dressing machines. The cost of performing this class of work in 1929 was reduced nearly 20 per cent as compared with costs of two years previous when handled under the old method.

The results of this test were so satisfactory that six similarly organized gangs were employed in 1930, and in 1931 the number was increased to eleven, eight gangs being assigned to main track territories and three to the larger terminals. These gangs included an average of about 75 laborers with plenty of supervision and each gang was equipped with an eight-tool tie tamping outfit, a power track jack and a ballast dressing machine. The full season's work for each gang was planned in detail before the gang was organized and this work was then programmed throughout the season. Charts showing weekly progress as compared with the program were kept up to date and it was noticeable that these gangs were generally up with or ahead of their programs. In each case the labor assigned to the maintenance gang was taken from the regular track labor forces for the territory on which it was working.

This railroad also handles all rail laying with system gangs. These gangs have from 170 to 175 laborers and are fully equipped with power operated spike pullers, adzing machines, rail laying machine, bolt tightener and track drill. One of these gangs will average approximately two track miles of rail relayed per day. As a result of systematic programming, using laborers who have become skilled in their own particular work and the necessary labor saving equipment, the cost per mile of track relayed has been reduced about 40 per cent as compared with costs five years ago.

In the early part of 1931 a system ballasting gang of 275 men was organized. Adequate supervision was provided, this gang having a general foreman, four gang foremen and eight assistant foremen. One machine supervisor, four machine operators, two timekeepers and a material clerk were also assigned to this gang. This gang has been following a system rail laying gang, making a four-inch raise on gravel ballast including all incidental work such as skeletonizing, tie renewals, unloading gravel and ties, dressing ballast to standard and cleaning up scrap, burning old ties, etc . Ballast was delivered at the rate of about 80 cars daily in regularly assigned gravel trains and was unloaded after 5.00 p. m. With this program and organization, interruption of traffic was minimized. The gang averaged 8 1/2 miles of completed ballasting per week at a total labor cost of $735.00 per mile as compared with a cost of $ 1 750.00 per mile four of five years ago when

similar work was performed by division gangs consisting of about 75 men each. This reduction in cost of ballasting approximated 58 per cent.

The Pennsylvania Railroad.

While this railway has not attempted any general reorganization of its maintenance of way forces, the heavier maintenance is now performed by gangs of sufficient size to operate mechanical equipment and properly perform the work. This practice has permitted a reduction in the number of sections with a corresponding increase in length and a considerable decrease in the amount of labor assigned to the sections for ordinary maintenance. The plan followed is briefly :

a) Organize special gangs in camp trains for rail laying;

b) Provide special gangs for raising track, spacing ties and tamping where considerable stretches of such work are to be performed; and

c) Adjust section forces in accordance with amounts of work remaining to be done on the sections.

The results of this policy reflect a 40 per cent reduction in cost of rail laying and a 33 per cent reduction in the present annual cost of track laying and surfacing and roadway maintenance as compared with four years ago, and a better general maintenance condition due to the fact that section forces are relieved of heavy repair work and are better able to attend to the maintenance of those portions of the track not requiring heavy repairs.

The special gangs are furnished to a large extent with power machines and tools, the use of which requires experienced labor for effective results. They are assigned to such territories where a large amount of continuous work is required on one or more sections. This does not relieve the section forces of their responsibility of maintenance and they may be required to do heavy work as in the past if the program of the special gangs is not extensive enough to cover all of the heavy work. In such cases the force is adjusted to meet the conditions.

Reports from the Central Region, which may be taken as typical of the railway, indicate that 86 per cent of its rail renewal work is performed by two specialized rail laying gangs averaging 90 men each, equipped with modern labor saving mechanical appliances. Other heavy maintenance activities handled by special gangs include about 95 per cent of all ballast cleaning, using « Moles »; all heavy ditching, using cranes in batteries; roadbed and ditch shaping with spreaders; and tie renewals, which are handled on heavy traffic lines by special gangs of from 20 to 40 men each.

On 5 June, 1931, your reporter, in company with the Committee on « Economics of Railway Labor » of the American Railway Engineering Association, made an inspection of a rail laying organization on the Eastern Division of the Central Region of the Pennsylvania Railroad at Bellevue, near Pittsburgh, Pennsylvania, U. S. A.

New 131-pound 39-foot rail was being laid to replace old 130-pound 39-foot rail. However, shortly after this date, the same gang began laying new 152-pound 39-foot rail, replacing old 130-pound 39-foot rail and used the same organization and equipment. The following are notes on organization and equipment in use on this gang, designated by this railway as the Eastern Ohio-Lake rail train.

Work.

Distribution by work train of rail, tie-plates, joint-bars, rail anchors, bolts, spikes, and tie plugs.

Dismantling old track, removing rail

anchors, spikes, bolts, joint-bars, rail, and tie-plates.

Preparing bed for new rail, including plugging old spike holes, adzing, and painting adzed surfaces of ties with creosote.

Laying new rail, including setting tie-plates, setting rail, applying joint-bars, bolting up, gauging, spiking, applying rail anchors, beveling joints, and bonding rail ends.

Picking up rail and material, making proper classification.

Organisation.

Distributing material — Local forces :

2 foremen;
1 work equipment engineer (crane operator);
14 laborers.

17

Rail laying gang (special organized unit for laying rail — moved from point to point) :

1 general foreman
1 inspector M. W. (mechanic)
1 clerk
2 foremen
2 assistant foremen
1 work equipment engineer (crane operator)
4 machine operators
78 laborers

90 *Total.* — Recruited from six Divisions of the Eastern Ohio-Lake General Division; each man holding rights on his home Division.

Commissary (operated by a contract commissary company) :

1 clerk (in charge)
1 chief cook
1 second cook
3 dining car attendants
1 car cleaner
1 yardman

8 *Total.*

Picking up material — Local force :

2 foremen
3 work equipment engineers (crane operators)
15 laborers.

20

Bonding :

4 signalmen.

Equipment and machines used.

For distributing :

1 crawler crane.

For picking up :

1 crawler crane.

2 locomotive cranes.

For laying :

1 *Metalweld compressor* — 280 cubic feet free air per minute capacity, equipped with overhead extension carriers for supporting pneumatic spike pullers. Operates four to six Ingersoll-Rand 99-C track wrenches;

4 *Nordberg adzing machines* equipped with 15-1/2" cutting heads;

2 *Norberg grinders* for sharpening cutting bits for adzing machines;

1 *Cullen Friestadt Burro crane,* 4-wheel, 1/2 swing type, 30-foot boom, capacity 2-1/2 tons;

1 *12-tool, type 20, Ingersoll-Rand compressor* equipped with air drive and cross trucks for operating 4 to 6 Ingersoll-Rand type CC-250 spike drivers and two Ingersoll-Rand 99-C track wrenches;

1 *Keystone joint beveling machine;*

1 Madden rail layer (power) for emergency use;

2 Class E motor cars (1 Casey-Jones 551 and 1 Fairmont A-5).
Trailers, trucks, etc.

For bonding :

2 Everett power bonding machines.

Train equipment.
Carried by special gang.

1 water tank
1 commissary supply car
1 dining car
2 dining-kitchen cars
6 sleepers
1 recreation-office car
1 oil car
1 flat car
3 gondola cars
1 tool car.

18

Line-up for work.

Distributing (work train):

2 foremen
4 on rail
2 on splice-bars
1 on bolts and nutlocks
1 on anchors
1 on spikes and plugs
4 on tie plates
1 on joint plates
1 work equipment engineer (crane operator).

17

First unit (rail laying):

1 foreman
2 starting spikes
2 starting nuts
1 removing rail anchors
4 spike pullers
1 compressor operator
2 denutters (air wrenches)
1 removing bond wires
1 welder (not carried on train)
2 joint spikes
1 removing splices
2 removing missed spikes
2 throwing out rail
1 removing tie plates
4 lowering ballast
2 driving down spike stubs
2 setting tie plugs
2 driving tie plugs
1 sweeping ties
1 water carrier.

35

Summary (first unit):

1 foreman.
1 assistant foreman.
1 machine operator.
32 laborers.

35.

Second unit (rail laying):

1 foreman
1 assistant foreman
4 adzers
1 machine operator (for adzing machine)
1 applying creosote
5 setting tie plates
5 setting in rail
1 work equipment engineer
2 grinding adzing bits
1 oiling rail ends
4 applying splices
3 gauging and spot spiking
5 setting spikes
4 air wrenches
1 compressor operator
5 spike drivers
2 applying rail anchors
2 tightening bolts
2 beveling joints
1 toolman
1 water carrier.

52

Summary (second unit):

1 foreman
1 assistant foreman
1 work equipment engineer
3 machine operators
46 laborers.

52

Total (rail laying):

1 general foreman
1 clerk
1 inspector M. W. (mechanic)
35 first unit
52 second unit.

90

Picking up (work train):

2 foremen
6 on rail
3 on splices
2 on scrap
4 on tie-plates
3 work equipment engineers (crane operators).

20

Bonding:

4 signalmen.

Total Forces:

Distributing . . .	17
Laying	90
Picking up	20
Bonding	4
	131.

The maximum laid by this gang was 627 rails 39 feet long, with a daily average of 272 rails. This gang normally took a stretch of track and closed it for traffic at 8.01 a. m. each day without anything unloaded or distributed, and worked eight (8) continuous hours without stopping for noon meal and closed at 3.59 p. m., with all tools and equipment loaded on their work train and all old rail, scrap and other released materials picked up clean, leaving the track open for traffic. All new materials, tools, etc., were kept on cars between these eight hour working periods, the men lived in suitable quarters in outfit cars and the entire camp train was ready to move for work at any point desired when they closed the day's work each afternoon.

This was one of the several gangs on the Pennsylvania specialized through training and with adequate equipment of mechanical appliances which were kept on this one class of work throughout the year. It was a very efficient organization and did much more and better work than a larger not specialized gang equipped with old style hand tools could accomplish in the same allotted time under similar conditions otherwise.

Mr. J. B. Baker, Chief Engineer, Maintenance of Way, on the Central Region of the Pennsylvania Railroad, has supplied us with some very interesting information and data.

In 1931 for handling rail laying work on the Central Region, two specialized gangs were used, both organized on the same basis, but using slightly different appliances. The gangs were known as the « Western-Pennsylvania Northern » (W.P.N.) and the « Eastern Ohio-Lake » (E.O.L.), the names being derived from the General Divisions from which the gangs were recruited and over which territory they worked.

The Western Pennsylvania-Northern gang was equipped with Nordberg spike pullers, a self-contained power unit which had been introduced and developed during the year 1930; while the Eastern Ohio-Lake gang was equipped with Ingersoll-Rand air spike pullers suspended from overhead arms extended both front and back from a special built Metal-weld self-propelled air-compressor. There was also a difference in the types of cranes used. The Western Pennsylvania-Northern gang was equipped with a 12-ton gas-driven Ohio locomotive crane, and the Eastern Ohio-Lake gang with a model No. 10, 180° swing Burro crane. The locomotive crane was used to a greater extent in multiple track territory where it was necessary to unload and load compressors and other machines each day where it was possible to obtain the use of track for longer intervals. The Burro crane was used mostly in single and double-track territory where, on account of traffic, it was necessary to close up and clear the track for traffic more often during a day's run, which was done by running to convenient side-tracks or setting all working equipment off the track by means of the transverse wheels on temporary set-offs built adjacent to track

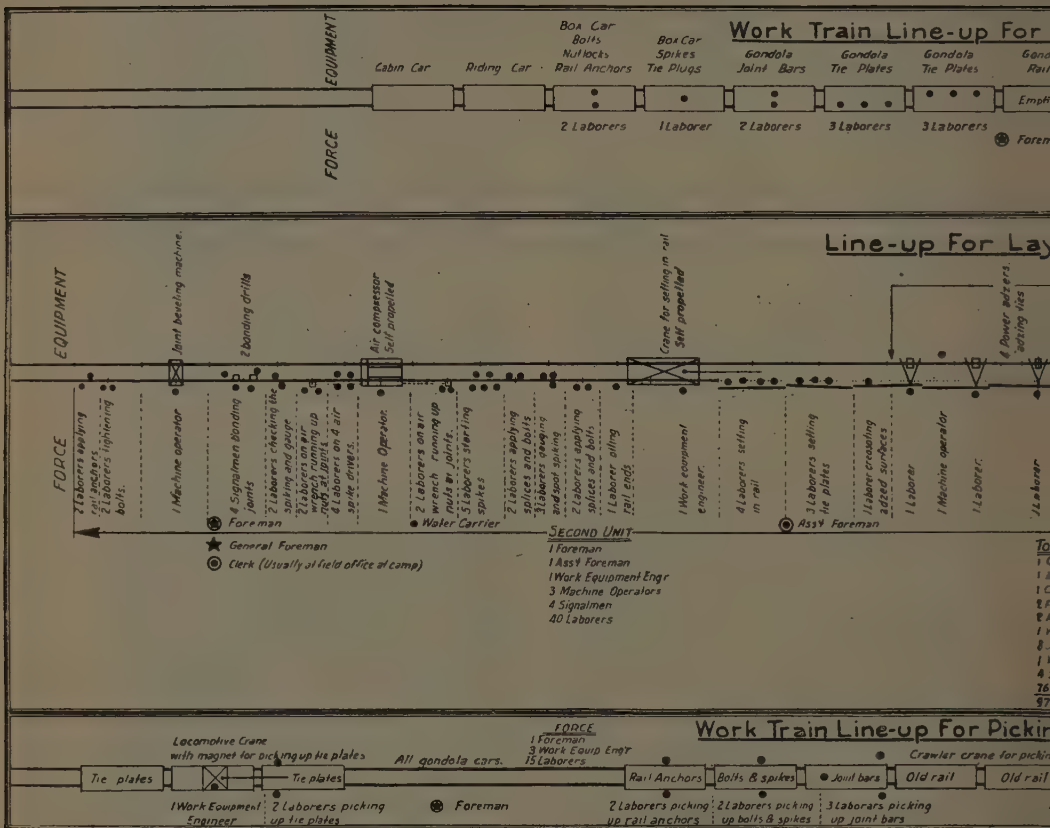
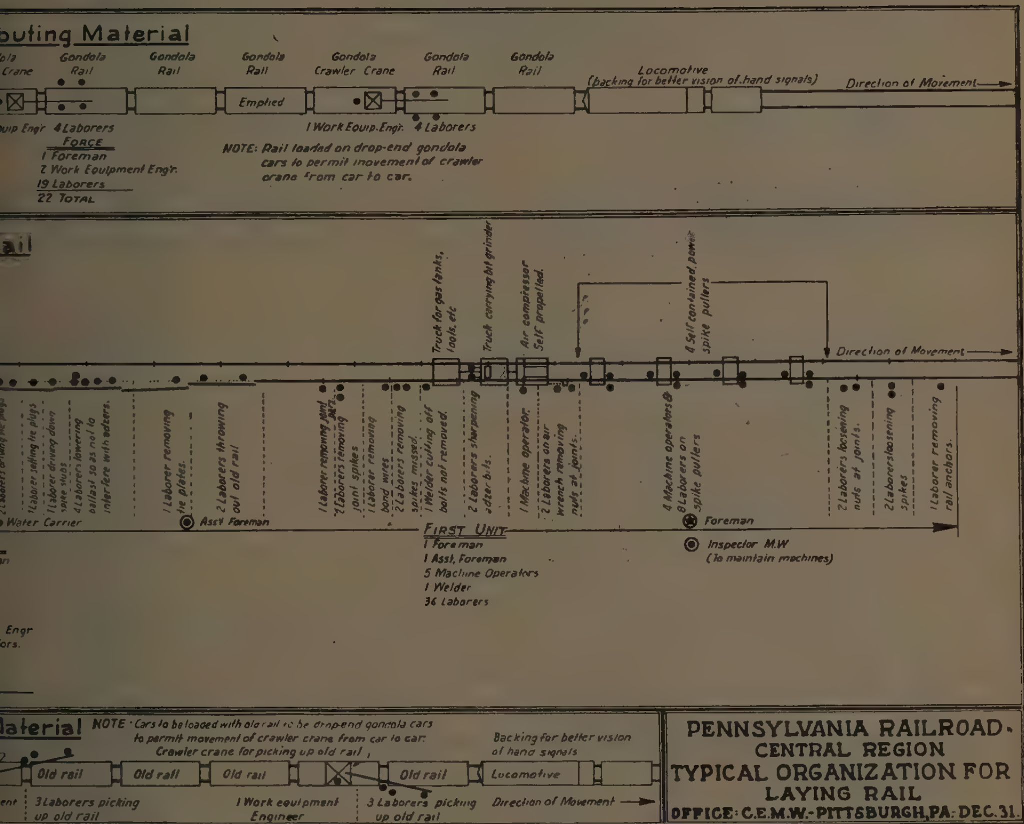


Fig. 1. — Typical c

on which working. While tracks were occupied by the rail-laying outfit it was used to the fullest extent possible for distributing and picking up material.

The work train line-ups shown by figure 1, « Typical organization for rail laying », were used to a large extent but often varied to meet local conditions. At times, especially in multiple track territory where the use of track was obtained for the entire day and where a work train in conjunction with the rail laying forces for handling the machines was necessary, the work train was composed of two engines, one working with cars containing material to be applied and distributing it ahead of



…on for rail laying.

the gang and the other in the rear of the gang picking up material so that when the procession had passed the work was completed.

With the set-up as shown on the plan, it was possible to distribute rail faster than it could be laid so that one engine was used with the work train and rail was all distributed in advance, and then the work train with a slightly different organization, similar to that shown on plan was moved back of gang for picking up, the entire operation being simultaneously completed.

The statement given below shows the amount of work performed, the machines used with cost of each, and an estimate of the total cost of laying rail.

Pennsylvania Railroad.

Central Region.

REPORT, RAIL LAYING. — YEAR 1931.

General information.

	West Pennsylvania-Northern.	Eastern-Ohio-Lake.
Total amount rails laid	54 250	33 247
Total tonnage rails laid	36 737	22 283
Maximum rails laid per day	627	471
Minimum rails laid per day	112	76
Average number rails per day	313	224
Average number tons per day	212	150
Number of days laying rail	173	148

Two trains laid in 321 train-days : 59 020 tons — or
184 tons per day per train — or
368 tons per day for two trains.

Summary of all costs.

		Per ton
I. Forces laying rail		$ 1.94
II. Distribution of rail and other track material (Estimated cost)		0.50
III. Picking up rail and other track material		0.54
IV. Other costs :		
a) Machines (interest, annuity to replace, and repairs)	$ 0.35	
b) Camp (repairs and supplies)	0.13	
c) Moving camp and equipment	0.09	
d) Miscellaneous (fuel, water, stationery)	0.10	
		0.67
Average total cost of laying rail, 1931		$ 3.65

I. — Forces laying rail.

COST PER EIGHT-HOUR DAY.

TITLE.	Rate.		West-Pennsylvania-Northern.		Eastern-Ohio-Lake.	
	Monthly or hourly.	Daily.	No. of men.	Cost per day.	No. of men.	Cost per day.
General foreman	$ 195.00	$ 9.21	1	$ 9 21	1	$ 9.21
Inspector M. W.	165.00	7.80	1	7.80	1	7.80
Clerk	122.50	5.79	1	5.79	1	5.79
Foreman	142 50	6.73	2	13.46	2	13.46
Engr. work equipt	0.68	5.44	1	5.44	1	5.44
Asst. foreman	0.54	4.32	2	8.64	2	8.64
Machine operators	0.54	4.32	8	34.56	4	17 28
Laborers	0.41	3.28	76	249.28	78	255.84
Daily labor cost	...	...	...	$ 334.18	...	$ 323.46
Rail train forces	....	...	92	...	90	...
Local forces :						
Welder (cutting bolts)	0.82	6.56	1	6.56	1	6.56
Signalmen (bonding)	0.82	6.56	2	13.12	2	13 12
Signalmen helpers (bonding)	0.58	4.64	2	9.28	2	9.28
Total av. daily cost	...	..	...	$ 363.14	...	$ 352.42
Total force	...	...	97	...	95	..

Daily rates for monthly men calculated on a basis of five days a week (the days actually laying rail).

II. — Distributing rail and other track material (Estimated costs).

Distributing (cost per day).		
2 crawler cranes-first cost \$ 8 500.	\$ 17 000.00	
15 years' life at 6 % depreciation — 2 cranes	\$ 730.00	
Interest at 6 % on \$ 17 000	1 020.00	
Repairs \$ 500 per crane	1 000.00	
Total.	\$ 2 750.00	
Assume 200 working days per crane per year :		
Cost per crane per day	\$ 13.75	
Gas and oil	10.00	\$ 23.75
Labor :		
1 foreman at \$ 142.50	6.73	
2 work equipment engineers at \$ 0.68 per hour	10.80	
19 laborers at 40 cents per hour	60.80	78.33
Work train charges (Including overtime) :		
Average cost per hour per train	\$ 11.00	
Cost per 10-hour day		\$ 110.00
Total cost distributing force		\$ 212.08

Such force will distribute rail at the rate of 8 cars per day (560 rails or 425 tons) 39-foot, 131-lb. rail, at 50 cents per ton.

III. — Estimated cost of picking up rail and other track material.

2 crawler cranes — first cost \$ 8 500 each	\$ 17 000.00	
1 locomotive crane	12 000.00	
Total.	\$ 29 000.00	
Annual costs :		
Depreciation on \$ 29 000 at 6 % — 15 years' life	1 245.00	
Interest — 6 % on \$ 29 000	1 740.00	
Repairs — \$ 500 per crane	1 500 00	
Total.	\$ 4 485.00	
Assume equipment used 200 days per year :		
Daily costs 4485/200 ×	22.42	
Gas and oil	15.00	
Total cost equipment.		\$ 37.42

Force :

1 foreman at $ 142.50	6.73	
3 work equipment engineers at 68 cents per hour	16.32	
15 laborers at 40 cents per hour	48.00	
		$ 71.05
Work train charges (Including overtime) :		
Average cost per hour per train $ 11.00.		
Cost per 10-hour day		110.00
Total cost picking up.		$ 218.47

This force and equipment will load rail at the rate of 600 rails per day (384 tons), 33-foot, 130-lb., at a cost of 54 cents per ton.

IV. — Cost of machines used on rail trains.

ITEM.	Cost.	Western-Pennsylvania Northern.		Eastern-Ohio-Lake.	
		Number.	Total cost.	Number.	Total cost.
Metalweld compressor	$ 4 600	...	...	1	$ 4 600
Ingersoll-Rand compressor	3 610	2	$ 7 220	1	3 610
Ingersoll-Rand spike puller	225	...	...	8	1 800
Ingersoll-Rand type 99C wrenches	275	5	1 375	5	1 375
Nordberg spike puller	1 100	6	6 600	...	...
Nordberg adzers	1 475	4	5 900	4	5 900
Nordberg grinders	100	2	200	2	200
Ohio locomotive crane	12 395	1	12 395	...	...
Burro crane	5 425	..	...	1	5 425
Ingersoll-Rand spike drive	195	6	1 170	6	1 170
Keystone beveler	600	1	600	1	600
Everett power drill	584	1	584	1	584
Madden rail layer	851	1	851	1	851
Push-cars	150	2	300	6	900
Motor-cars	450	...	...	2	900
Bonding drill	375	1	375	1	375
Trailer cars	200	...	...	4	800
Total investment in machines used.	...	...	$ 37 570	...	$ 29 090
Total investment in machines used on both trains					$ 66 660

Estimated annual cost of all machines used on rail trains.

(Including interest on investment, annuity to replace, and repairs.)

ITEM.	First cost.	Average life, years.	6 % interest on invest-ment.	6 % annuity to replace.	Estimated yearly repairs.	Total annual charges per machine.	Western-Pennsylvania-Northern.		Eastern-Ohio-Lake.	
							Number used.	Total annual charge.	Number used.	Total annual charge.
1	2	3	4	5	6	7	8	9	10	11
etalweld compressor . . .	$ 4 600	10	$ 276	$ 349	$ 500	$ 1 125	...	...	1	$ 1 125
gersoll-Rand compressor . .	3 610	10	217	274	500	991	2	$ 1 982	1	991
gersoll-Rand spike pullers .	225	5	13	40	150	203	...	...	8	1 624
gersoll-Rand 99C wrenches .	275	5	16	49	50	115	5	575	5	575
rdberg spike pullers . . .	1 100	5	66	195	200	451	6	2 766	...	...
rdberg adzers	1 475	5	89	262	150	501	4	2 004	4	2 004
rdberg grinders	100	5	6	18	10	34	2	68	2	68
io crane	12 395	15	744	532	1 000	2 276	1	2 276	...	...
rro crane	5 425	15	326	233	500	1 095	...	...	1	1 059
gersoll-Rand spike drivers .	195	6	12	29	75	116	6	696	6	696
eystone bevelers	600	4	36	137	100	273	1	273	1	273
ower drill	584	8	35	68	60	163	1	163	1	163
adden rail layer	851	10	51	65	10	126	1	126	1	126
ush cars	150	5	9	27	20	56	2	112	6	336
otor cars	450	10	27	34	50	111	...	...	2	222
onding drill	375	8	23	44	35	102	1	102	1	102
railer car	200	5	12	35	20	67	...	...	4	268
otal yearly cost to trains . .	...	...	...	...	...	...	...	$ 11 143	...	$ 9 632

Summary of costs per ton per rail laid :

1. **Forces** (actual laying) :

Average daily costs Western-Pennsylvania-Northern gang	$ 363.14
Average daily costs Eastern-Ohio-Lake gang	352.42
Total daily costs, 2 gangs. . . .	$ 715.56

Distributed to 368 tons per day two trains.
Average cost per ton of rail . . . . $ 1.94

2. **Distributing rail and other track material.**

Cost per ton of rail			$ 0.50

3. **Picking up rail and other track material :**

Cost per ton of rail.			0.54

4. **Other charges.**

a) *Machines*

Yearly cost, machines Western-Pennsylvania-Northern gang . .	$ 11 143		
Yearly cost, machines Eastern-Ohio-Lake gang	9 632		
Total yearly cost, 2 trains. . . .	$ 20 775		
Distributed to 59 020 tons of rail laid. Average cost per ton of rail		$ 0.35	

b) *Camp expenses.*

Repairs (only) to 34 cars retired from reg. service at $ 200 per car.	$ 6 800		
Bedding, laundry (not done by commissary company) and miscellaneous camp expenses per year.	1 200		
Total yearly cost. . . .	$ 8 000		
Distributed over 59 020 tons. Average cost per ton of rail.		0.13	

c) *Moving camp and equipment.*

Work train or other crew moved, each train average once a week — 8 hrs. wk. train at $ 11.00	$ 88		
Distributed over weeks work (5×184 tons) 920 tons, or cost per ton of rail		0.09	

d) *Miscellaneous expenses.*

Water, fuel, office, medical and other supplies $ 100 per week per train.			
Distributed over weeks work (5×184 tons) or 920 tons. Cost per ton rail		0.10	
Total « other charges » — Average cost per ton of rail.			0.67
Average total cost per ton of rail			$ 3 65

It is noted that the number of rails laid per day varied considerably, the minimum being 76 and the maximum 627, which number was obtained in replacing rail of like section not involving change of tie-plates and adzing ties. The 76 were laid through a tunnel under adverse weather conditions with unusual heavy traffic.

The statement shows the cost of the work in detail. There is a variation in the amount of work done and the average cost per ton between the two gangs which is the result of one gang work-

Fig. 2. — Rail laying gangs, Pennsylvania Railroad.

Fig. 3. — Adzers, Pennsylvania Railroad.

Fig. 4. — Crane setting in rails, Pennsylvania Railroad.

Fig. 5. — Spike drivers, Pennsylvania Railroad.

Fig. 6. — Bolt tighteners and rail end beveling machine. Pennsylvania Railroad.

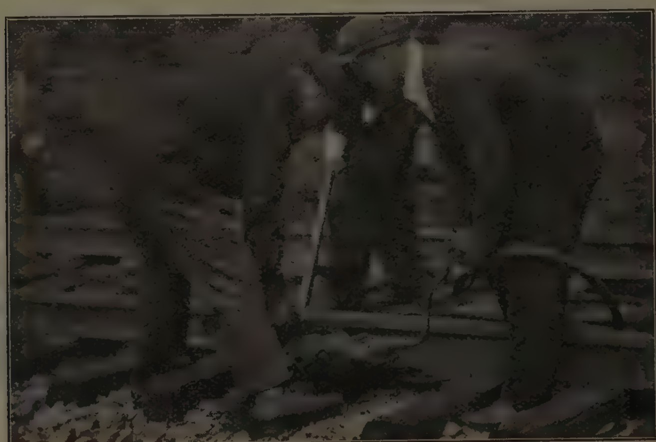


Fig. 7. — Bolt tightener and de-nutter in operation.

Fig. 8. — Rail train unloading and picking up materials.

Fig. 9. — Rail laying. — Front view of adzing machines at work.

ing to a larger extent in territory where it was possible to obtain uninterrupted use of track for longer intervals.

Equipment and machines costing $66 660 were used with the two gangs; the interest on which, together with repairs and an annuity to replace the machines when worn out or retired on account of obsolesence, amounted to $20 775 per year or about $130 per day actually used, or $0.35 per ton of rail laid.

The cost of laying rail, including all sections and under all conditions during 1931 averaged $3.65 per ton including all costs.

They have not laid rail entirely by hand for a number of years and have no accurate figures available as to the cost of hand work that can be used for 131-pound and 152-pound sections involving the changing of all tie-plates and the adzing of all ties. Figures worked up in 1929 show that for relaying 130-pound rail, replacing 130-pound rail not changing plates or adzing ties and not including distributing or picking up material, cost $4.00 per ton. Therefore, it is conservative to assume that the work done in 1931, without the use of machines except possibly a rail derrick, would have cost on an average $6.50 per ton. But the workmanship, especially the tie-adzing, would not have been done as well, and unquestionably there would have been more personal injuries and costly claims to have been settled.

Assuming the work could have been done for an average cost of $ 6.50 per ton, a saving of $2.85 per ton was effected by the modern methods used which for 59 020 tons laid amounts to $188 200 on the work of the year; during which the rail program was much restricted on account of general adverse business conditions.

Savings as the result of fewer delays to traffic can not be estimated to any degree of accuracy. With but one rail laying operation in progress on a division, and that only for a short time, the Operating Department can co-operate better with the Maintenance Department and secure longer and freer use of tracks than where several rail laying operations are in progress at one time.

In order to avoid traffic delays studies were made of traffic conditions and requirements in advance of the laying of each stretch, and the working time of the rail laying forces was adjusted to avoid traffic as much as possible and obtain the uninterrupted use of track for the longest periods of time available.

In one instance on a single-track railroad, where the schedule provided for a passenger train at intervals of not more than an hour apart with several freight trains intervening throughout the day from 7.00 a. m. to about 12.00 midnight with but one freight train between midnight and 7.00 a. m., the one freight train was advanced so as to pass over the stretch in question before midnight and the rail laying forces started work at 12.01 a. m. which permitted seven hours uninterrupted use of track. Laying rail at night costs a little more but a greater performance was made possible by avoiding delays that would have resulted in attempting to clear for traffic. Moreover, an attempt to have laid the rail in the face of traffic. would also have resulted in some delay to traffic, the cost of which can not be determined.

The Pennsylvania have made rapid strides in their progress in methods of laying rails and have effected much economy from their machines and methods employed, yet certain changes and further developments are now being suggested that indicate that their problem of rail laying has not yet been solved and there is still opportunity for worth while economies to be developed.

Boston and Maine Railroad.

This railway has recently made some very decided changes in its organization for track maintenance with satisfactory resulting economies. On heavy traffic main lines with good rail and ballast conditions, large maintenance gangs of approximately 70 men are used for complete out-of-face rehabilitation consisting of resurfacing, renewal and respacing of ties, gauging and lining, trimming of ballast and sub-shoulders and other general work. These gangs are made up of experienced and specialized foremen and laborers and their work is scheduled and controlled. The rehabilitation is done to the extent which will put the track in shape to withstand the traffic demands for a period of four to five years with greatly reduced maintenance labor. After a section has been gone over in this manner, the section forces are reduced to the minimum required for patrolling, spot surfacing, bolting and other minor duties, and the savings so effected represent large returns on the cost of the rehabilitation work.

This railway, however, has not attempted any change in its method of maintaining heavy traffic lines where rail is light and ballast conditions are not so good.

On its light traffic branch lines they have consolidated adjoining sections and cover the territory some time during the period from April to October, inclusive, by a floating maintenance gang consisting of approximately twenty men. The track is completely retied and spot surfaced. After the territory has been covered by this gang, the ordinary maintenance consisting of patrolling, bolt tightening and other minor work is handled by a foreman and one laborer excepting that the gang is increased by two laborers during winter months to handle shimming, cleaning snow from ditches and similar work. In the first test of this method, made in 1930, labor costs for the year were reduced nearly 38 per cent, and the results have been so satisfactory that the method has been adopted for a number of other light traffic branches with equally good results and economies.

While the railway's report so far principally covers its practice with respect to track maintenance other than large ballasting and rail laying projects, it handles such projects with large specialized gangs fully equipped with labor saving devices and machines and utilizing traffic diversion whenever possible.

A typical job of rail laying on this railway is exemplified in the September, 1931, issue of *Railway Engineering and Maintenance,* an outstanding American publication devoted to railway maintenance interests. It reports that a gang averaging 156 men, with power spike pullers, power adzers, a crane, pneumatic nut runners, pneumatic spike drivers, power bonding and rail drills, and both cutting and welding torches, laid as many as 734, 39-foot rails of 130-pound section in 9-1/2 hours of actual working time and 2 hours travel time.

The above figures do not include the distribution of the rail and track fastenings, or the picking up of the old rail and fastenings, but do include the removing of all the worn track material, out-of-face adzing, full tie plating, rail laying, spiking, bolting, anchoring, bonding, and the disconnecting of the old rail. All of the work was done without the interference of traffic, as full use of the track was obtained during the working hours; and, upon the completion of the work, the track was restored to service without speed restrictions, and with all work completed except the picking up of the old track materials.

The particular rail laying work described was done on the double-track main line between North Adams, Massachusetts, and Johnsonville, New York, where 100-pound rail with ordinary

angle-bar joints and single shoulder flat top tie plates was relaid with 130-pound rail on 8-inch by 12-inch double shoulder tie plates, weighing approximately 19 pounds each. New Neafie joint bars and base plates were applied at the joints. Nine anti-creepers were applied to each rail. The track is ballasted with washed gravel and crushed trap rock.

In the actual rail laying work a well organized gang averaging 133 men, including foremen, was employed. They were spread over about a mile, with each individual group in the organization working independently of the other groups to avoid interference. The usual organisation employed while operations were in full swing is given in the following :

Cutting joints and pulling spikes : 1 foreman, 1 welder and 11 men — (3 power spike pullers).

Throwing out rail and preparing to adze : 1 foreman, 1 assistant foreman and 16 men.

Adzing : 1 foreman and 7 men — (3 power adzers).

Installing tie plates : 1 assistant foreman and 7 men.

Laying rail : 1 foreman, 1 operator, 1 welder and 7 men — (gasoline-operated crane and one acetylene-cutting outfit).

Assembling joints : 1 assistant foreman, 1 operator and 12 men — (one 8-tool tie tamper compressor, 2 pneumatic nut runners).

Gauging and spiking : 3 foremen, 1 operator and 38 men — (one 12-tool tie tamper compressor and 6 pneumatic spike drivers).

Applying rail anchors : 1 assistant foreman and 2 men.

Signal bonding, when stranded plug bonds were used : 1 signal foreman, 2 signalmen and 5 helpers — (3 power bonding drills).

Binding, when welded bonds were used : 4 welders, 2 welder helpers, 1 signalman and 1 signal helper — (4 acetylene welding outfits).

Dismantling old rail : 1 assistant foreman, 1 operator, 1 welder, 1 welder helper and 7 men — (One 4-tool tie tamper compressor, 2 nut runners and an acetylene cutting outfit).

Total men actually engaged in rail laying	133
Miscellaneous : Including 4 cooks, 4 cook helpers, 1 watchman, 2 waterboys, 2 equipment maintainers, 1 cost man, 7 timekeepers and material checkers . . . . . total	21
Total men in rail laying force . . .	154
Men picking up old rail, including foremen	19
Total men on entire job	173

All turnouts in the territory covered by the rail laying program were relaid in advance. Laying through road crossings, however, was included in the general rail renewal work, and such additional work was done by the regular rail laying forces temporarily reorganized to meet conditions.

The first operation in the work was the breaking of the joints at every twentieth joint on tangent track and at every tenth joint on curves to facilitate the work of throwing or rushing out the old rail. The next major operation was spike pulling with three Nordberg spike pullers operating together within a range of about 100 feet. Each machine manned by three men, pulled spikes continuously on both sides of every third rail. In addition to the nine men controlling the three machines, two men with claw bars pulled such spikes as could not be gripped readily by the machines.

The throwing out of the old rail beyond the end of the ties was done by six men with lining bars. Immediately following this gang came the group of ten men removing the old tie plates and placing tie plugs. In this latter group, two men removed tie plates, four placed and two drove the tie plugs, one man with a spike maul, assisted by the foreman with a punch mounted on a handle, drove all spikes without heads so that they would not interfere with the adzers, and one man with a rake levelled the

ballast between the ties where necessary to clear the way for the adzing machines. All of the tie plugs were driven by simple tamping tools which permitted the men to stand in an upright position while working. This tool consisted of a round flat steel plate, about eight inches in diameter, welded to a vertical pipe handle.

The adzing was done with three Nordberg power adzing machines, each operated by one man. These machines operated progressively over the ties, the first machine making the initial cut, the second machine making another cut, and the third machine making the finished tie plate seat. In this manner the three machines were kept relatively close together. The other four men included in the adzing gang were employed in repair work, such as changing the heads of the adzing machines, sharpening the cutting knives, etc. Sharpening and the assembling of the heads was done in one end of a gondola car, pulled along by the crane setting in the rails. All men employed around the adzing machines were required to wear goggles and shin guards for safety.

The tie plating gang included two men who, with brushes, painted the adzed portion of each tie with creosote, and five men who placed the new plates. In addition to placing plates, one man aided the assistant foreman in charge of this operation in measuring for the location of joint plates when it was necessary to install a short rail, as on curves. The creosote used was relatively thin and was applied cold. The supply of creosote was carried along in the gondola car previously mentioned.

The actual setting in of the rail was done with a Burro crane. The 10 men employed in this operation included the foreman, one crane operator, three men guiding it into position, four men gaging and spiking the rail sufficiently to allow the Burro crane to pass, and one man holding the expansion shims. One of the three men employed in actually setting the rail in place was a welder who, with an Oxweld cutting outfit, made the necessary rail cuts.

The standard gondola car, behind the Burro crane, was used not only for the storage of the creosote and as a workshop for repairs to the adzing machine, but also for the movable storage of a large number of track tools and supplies such as tie plugs and oxy-acetylene equipment.

The gang of 14 applying the joint bars followed immediately behind the Burro crane and was equipped with an Ingersoll-Rand compressor, which operated two pneumatic nut runners and also furnished air for a pneumatic track drill used in redrilling the rails where cuts had been made. This group was made up of one assistant foreman and six men employed in assembling the joints on the rail and starting the nuts, while the compressor operator and six men were employed in the operation of the nut-runners to tighten the nuts.

The gauging and spiking force of 42 men, which was equipped with five to eight track gauges, Ingersoll-Rand compressor and six Ingersoll-Rand pneumatic spike drivers, was split up as follows: One man, with a claw bar, pulling the few spikes which had been driven temporarily by the rail laying crew; one man, with a gauge and lining bar, barring the rail to gauge; four men straightening tie plates; a foreman and six men gauging and gauge spiking; a foreman and 18 men setting spikes; a foreman compressor operator and six men driving the spikes with the air hammers; and two men, with spike mauls, driving the spikes with the air hammers; and two men, with spike mauls, driving missed spikes and straighthening cocked plates. This group did such lining as was required, as they progressed.

The men operating the pneumatic spike drivers were spread out over a distance of about 25 feet directly behind

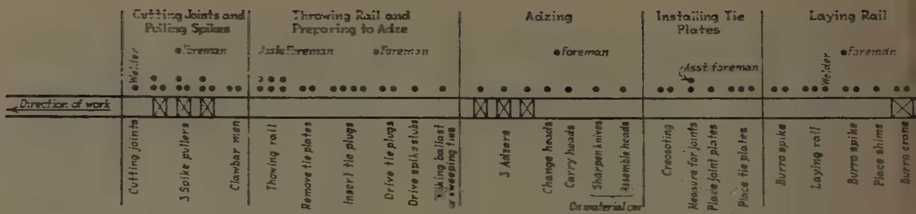


Fig. 10. — Rail gang organiza

the air compressor, three of the men single spiking on the inside of the rail, each man driving every third spike, while the other three men were single spiking on the outside of the rail in the same manner. The hose to the spikers was carried overhead on a pipe carriage or rigging, 23 feet long, the front end of which was supported on the top of the compressor, while the rear end was carried by a light structural steel frame supported on a pair of flanged wheels which operated on the track. The effectiveness of the arrangement used is seen in the fact that the whole outfit moved along, driving all spikes, at a uniform speed about equivalent to a slow walk.

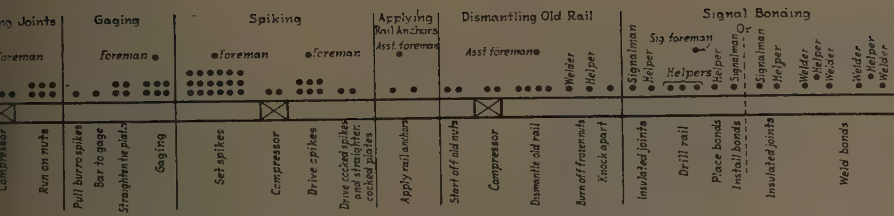
The application of anti-creepers was done by assistant foreman and two men, in the usual manner, with hand tools.

The signal bonds were next applied. Two types of bonds were used in the work, O-B welded bonds when carbon steel rails were being laid and stranded plug bonds when medium manganese steel rails were being laid. Four welders and two welder helpers equipped with four Oxweld welding outfits, two mounted on each of two push cars, applied the O-B bonds. The installation of insulated joints and wiring in connection with them, was handled by a signalman and helper. When the stranded bonds were being applied, the signal foreman, two signal men and five helpers making up the gang were equipped with three Everett power bonding drills. The drills worked progressively, each one drilling at every third joint. As was the case with the welded bonds, one signalman and a helper took care of the insulated joints.

Finally came the dismantling of the old rail. The gang doing this work consisted of an assistant foreman, a compressor operator, one welder and eight men, and was equipped with air compressor with two nut runners and an acetylene cutting outfit. Two men started the old nuts with hand wrenches, four backed off the nuts with the nut runners, the welder burned off frozen nuts and such others as the wrenches could not start, and the final man in the gang knocked the old joints apart so that the rail was ready to be picked up.

One line of rail was relaid continuously throughout the day, the opposite rail being brought up the following day. At the start of the day's work the men in the rear gangs secured mauls, claw bars or lining bars from the supply car and assisted in getting the regular advance gangs well out ahead before dropping back to their own regularly assigned positions. Within about 30 minutes the entire force was working smoothly in accordance with the normal organization for continuous operation. At a predetermined time in the afternoon, the advance gang came to a stop, and then the men of the succeedings gangs as they came up to the stopping point, fell back into the rear gangs, gauging, spiking, and applying joint bars and anticreepers, in order to close up the work.

The rail laying organization on the Boston and Maine was made up of the extra gangs from the six districts of



...ston and Maine Railroad.

the Fitchburg Division, each of these gangs assembling at the scene of operation with its own boarding car equipment and foremen. During the work, the different camp trains were kept together and as near the work as possible, being moved up with the progress of the work as some point ahead proved more convenient or advantageous. Only one work train was employed with the rail laying organization, this train being used to take the men to and from the work, and to pick up the old rails and track fastenings.

The loading of the old rails and fastenings was done just as close behind the dismantling crew as possible. This was effected by a foreman and 18 men with a mechanical rail loader located between two gondola cars in the work train. All of the old track fastenings were picked up by hand, classified as to scrap or relay, and loaded on to flat cars.

The distribution of the new rails and fastenings for the rail laying work was done prior to the actual rail laying by a work train. In this work, the rails and fastenings were distributed in two different runs of the train. During the rail run, with an average gang of 20 men, the train was usually made up with an air-operated rail loader and a gasoline-operated locomotive crane, each located between cars of rail; while during the material run, which was made with an average gang of nine men, the train included only material cars.

It was endeavoured to confine all rail laying work to 10 hours each day, this including travel time to and from the boarding cars. The total force involved in the work, including foremen, the men bonding, those picking up the old rails and fastenings, and a group of miscellaneous employes such as cooks, timekeepers, watchmen, waterboys and equipment maintainers, ranged from a minimum of 159 men to a maximum of 178 men, and averaged about 173 men. The force engaged in the actual rail laying operations, that is, the above total force excluding those men picking up the old rails and fastenings and those classed as miscellaneous, ranged from a minimum of 128 men to a maximum of 138 men, and averaged about 133 men throughout the work.

With this force, the rail laying work, which was carried on for 12 days, increased steadily in efficiency. On the first day of the work only 503 rails were laid. The third day the number was increased to 577 rails; the fifth day the number had been further increased to 641 rails; and by the ninth day, the number had jumped as high as 734 rails. The average number of rails laid each day during the 12 working days was 583, equivalent to approximately 22 700 lineal feet. On the basis of 8-1/2 hours of working time, this was equivalent to laying 68 rails an hour, or a rail approximately every 53 seconds. On the day on which the best record of 734 rails was made, the rails were laid at the rate of 82 an hour or a rail approximately every 44 seconds.

Figure 10 shows the rail gang organization on the Boston & Maine as described above.

The foregoing reports on operations of specialized gangs equipped with a full complement of mechanical appliances in handling rail relaying and other maintenance of way work are typical for the various kinds of maintenance work, particularly the heavy work performed, on the railways of North America. The appliances named in these reports were the ones in use in these particular gangs reported on and do not by any means cover the numerous mechanical appliances available and in use on these railways. Various manufacturers often provide different types of appliances for doing the same kind of work. There are now mechanical appliances of varying merits on the market for performing not only all kinds of work on the maintenance of track and roadbed but also structures on the railway as well. These are too numerous to attempt to describe and illustrate in this limited report. A few of these appliances are described in reports to previous sessions and Bulletins of the International Railway Congress. Also full detail information as to a list of the manufacturers of any of the different types of mechanical appliances manufactured and used in North America can be secured by any one interested to that extent through communication with the National Railway Appliances Association, 1014, South Michigan Avenue, Chicago, Illinois.

Motor cars, gasoline driven, are almost universally used for transporting men and materials to and from the work.

In the construction and maintenance of the roadbed, including ditches and sub-drainage, steam shovels, air dump cars, spreaders, ditchers, ditch shapers, trenchers, plows, drills and cranes of many types are among the appliances used. The cranes operate on the railway track or off the track on caterpillar treads. They are equipped with various devices such as clam-shell and drag-line buckets, electric magnets and other convenient means of taking hold of the work.

Snow and ice are removed mechanically with the most modern devices including rotary and flanged plows. Spreaders with ice cutter attachments, flangers, and melting devices (gas, electric and chemical), for use around switches and interlockers are also employed.

Weeds are destroyed by cutting machines, chemical, burning and whipping methods. Gasoline driven mowers operate on and off the track. Chemicals are applied by sprays of liquid and dust that range in size and type from large devices which operate as trains on the track to small hand machines carried on the shoulder of the laborer. Weed burners are of several types that kill and burn the vegetation by heat from oil and gas flames or superheated steam applied direct to the plants. Discers that plow up or harrow the ballast are also operated on the track. Whippers are applied to the axles of tenders of locomotives that operate on important branch lines. These beat down the vegetation to keep it from fouling the top of rail and are only a very crude method of weed destroyer.

In the handling of ballast, cranes and conveyors are used for loading at the source of supply and special ballast cars are used for transporting and unloading. The latest development in these is a selective unloading type with hoppers that will unload in any desired quantity automatically through hopper controls in any portion (center, side or both) of the track section as selected by the operator. Ballast plows of many types distribute the ballast after unloaded to save labor trucking and shoveling.

In the applying of ballast there are numerous devices for track raising and tamping operated by gasoline, air and electricity.

Ballast cleaning is handled by power

Ballast cleaner cleaning both outer shoulder and center ditch on double track line.

Fairmont Mogul ditching machine: just backing out of cut with ditch box full of dirt, on way to a low spot to dump it.

Self-propelling crane with magnet, Chicago, Milwaukee, St. Paul & Pacific Railroad, U. S. A.

Self-propelling crane with clamshell attachment. Operates without a locomotive on Chicago, Burlington & Quincy Railroad, U.S.A.

Oven-type weed burner (approaching).

Weed mower cutting first or inner swath on both sides.

Cutting second or outer swath on both sides.

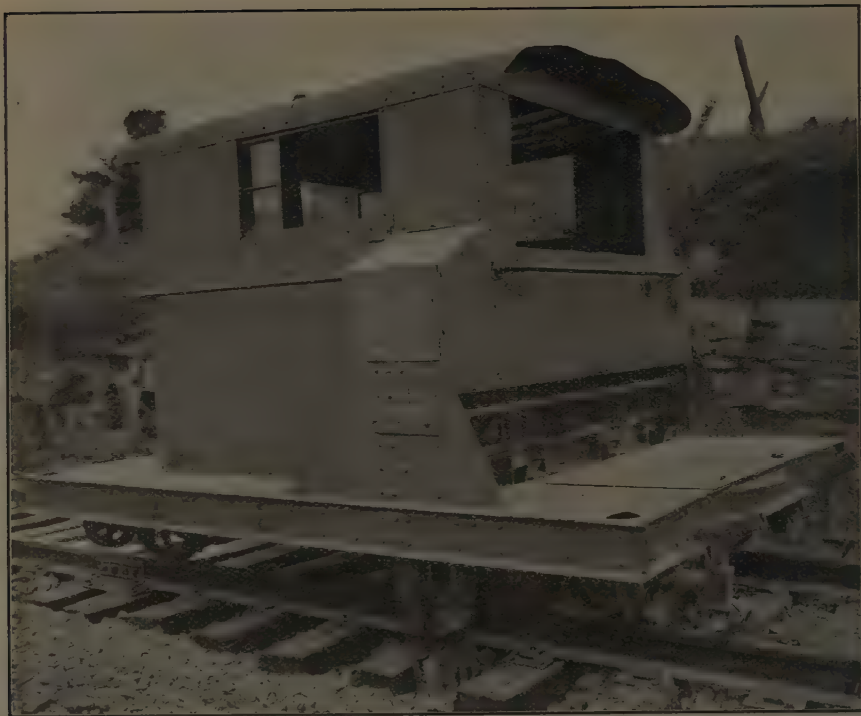
Caterpillar tractor cutting surface ditch.

Caterpillar tractor with pole hole digger.

Caterpillar tractor handling rail.

Caterpillar tractor grading earth.

Caterpillar tractor used to relay rail.

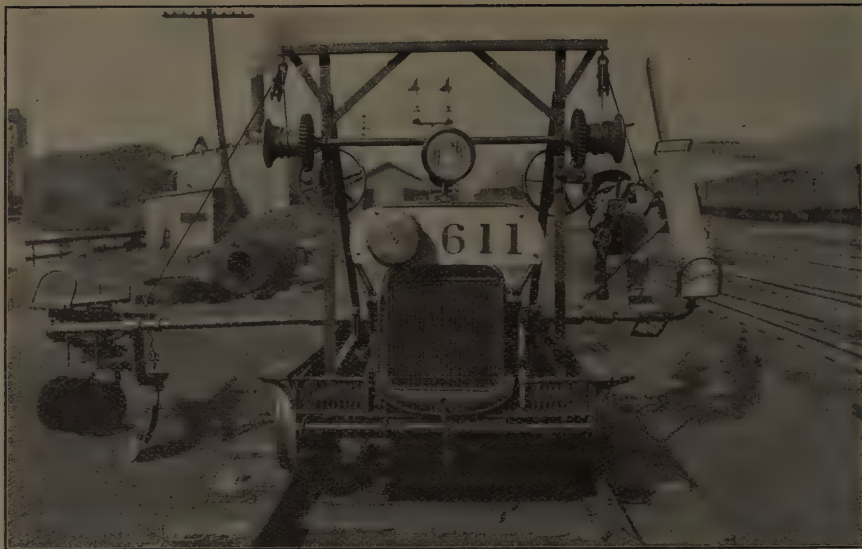


Jackson power ballaster, gasoline driven. Delaware & Hudson Railroad, U. S. A.

Clarke air dump car, Delaware & Hudson Railroad.

Gasoline crane with magnet on Delaware & Hudson Railroad.

Combination track jack and track shifting machine, gasoline driven, on Delaware & Hudson Railroad.



Weed discing machine attachment with motor car on Delaware & Hudson Railroad.

Electric screw spike tightener on Delaware & Hudson Railroad.

Syntron electric power unit.

1.- Chicago Pneumatic Tool C°. electric screw spike tightener.

2.-4 Syntron wood boring machine.

Delaware and Hudson Railroad.

Gasoline power jack on Delaware and Hudson Railroad

Power track ballaster and tie tampers (electric), on Delaware and Hudson Railroad.

screens alongside and on the track, driven by gasoline, steam, air and electricity. These vary in type and magnitude from a large organization with an appliance that requires a complete work train to a small device operated by a few men alongside of the track.

In tie applications, mechanical adzers, saws and scorers are used.

In the maintenance and relaying of rail in the track, some of the appliances and machines used are the Sperry transverse fissure detector, many kinds of cranes for handling and setting in the rails, mechanical spike pullers and drivers, bolt tighteners and de-nutters, rail drills (manual, air and electric), rail saws, grinders, rail oilers for wear prevention and protection from brine drippings, welders (oxy-acetylene, electric and fusion), joint bevelling machines, bonding machines, track liners, expansion adjusters and many other miscellaneous devices to save labor and facilitate the work.

Great Britain.

For the Railway Companies of Great Britain, a suggested reply to the questionnaire as sent out on this subject was submitted by the Railway Clearing House, London, subsequent to a conference by the engineers of these railways, and has been used as a basis of the report for this country.

In Great Britain mechanical appliances are used only to a very small extent, partly experimental.

The machines used have enabled the work to be carried out more expeditiously, with a saving in cost. The extent of saving is difficult to assess; but in the case of the building up of worn crossings, this can be done at about one-fifth of the cost of replacing them, and there are good grounds for anticipating a further life after the crossing is built up, aproaching that of the previous life of the crossing.

The use of mechanical tools has not been developed to such an extent as to justify the establishment of a special organization for the maintenance of the permanent way by such means.

Some of the mechanical appliances for the maintenance work are as listed below :

Cranes.

Steam cranes are in general use for loading, unloading and placing crossing work in position.

Also a petrol electric track-layer is in experimental use on the London & North Eastern Railway for replacing and/or renewing sections of tracking. This machine, called the « Morris track-layer », was constructed by Messrs. Herbert Morris, Ltd., Loughborough, and is illustrated by figures 11 to 13 inclusive. The machine is used to lay permanent way track in sections, two rails with the necessary sleepers, chairs and fastenings, completely assembled, and requiring only to be fished up to the adjoining length when it has been placed in position by the tracklayer.

The tracklaying train consists of :

1. *A cantilever wagon.*

This consists of a crane with fixed horizontal jib mounted on a bogie truck. The cantilever is carried on side frames between which the length of track being dealt with is passed. A trolley, provided with travelling and hoisting gear, is moved along the cantilever as required, the length of track being suspended from a special lifting bail; travelling motor 6 horsepower, travelling speed 200 feet per minute, hoisting motor 15 horsepower, hoisting speed 25 feet per minute. Total weight of cantilever wagon 61 tons.

2. *A train trolley.*

This conveys the length of track along the train. It consists of a braced frame spanning the waist of the wagon and runs on tracks mounted on the side of the wagon. It is fitted with travelling and hoisting gear. Travel-

Figs. 11 to 13. — « Morris » track layer.

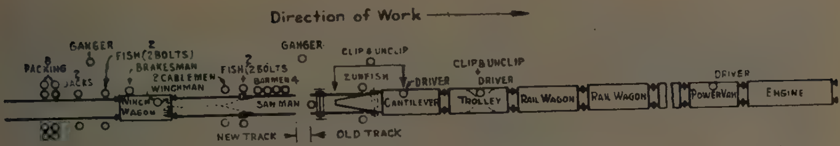


Fig. 11. — Diagram showing manning.

Fig. 12.

Fig. 13.

ling motor 11.3 horsepower, travelling speed 300 feet per minute. Hoisting motor 15 horsepower. Hoisting speed 25 feet per minute.

3. *Material train.*

This consists of 19 bogie wagons fitted with track for the train trolley and power conductors.

Length over headstocks . .	47 ft. 6 in.
Length over buffers . . .	50 ft. 6 in.
Maximum load	30 tons
Track capacity	6 lengths of assembled track 45 feet long.

The train trolley, with a length of track suspended, can pass a wagon loaded with five lengths of track, stacked one on top of the other. Couplers for the power conductors are provided and also bridging pieces for the train trolley rails. These pieces are discontinued and housed, when not required, for the passage of the train trolley, as when travelling.

These wagons will shortly be replaced by new wagons designed to carry 60-foot lengths of track to accelerate the operations.

4. *A power van.*

This is a 12-ton covered goods van containing a petrol-electric generating set of 72 horsepower, the fuel tank and the necessary switchgear. It supplies power for the tracklayer train at 100 volts D. C.

The tracklayer will deal with plain track only, not with point and crossing work. It can be worked on straight road and on curves flatter than 25 chains radius.

Between January, 1930, and July, 1931, 14 ½ miles of track have been relaid on the London & North Eastern Railway by the tracklayer. The whole of this work has necessarily been experimental, and the speed of the work has been limited by the necessity of using 45-foot lengths of track, no wagons being available for dealing with longer lengths. When the new wagons for dealing with 60-foot lengths are obtained, it is anticipated that the cost of relaying will be reduced. Figure 11 shows the arrangement of equipment and the manning of this tracklayer.

Welding sets.

Petrol-electric welding sets and grinders for the building up of worn parts of crossing work, are supplied by Messrs. Quasi-Arc Company, Ltd., 15, Grosvenor Gardens, London, S. W. I., and consists of a 11.9 horsepower, four cylinder « Dorman » petrol engine and a special lightweight generator 60/30 volts, 200 amperes, and a current regulator 30/200 amperes. The « Dorman » engine and generator (fig. 14), when assembled, measure 5 feet long by 2 ft. 2 in. wide by 3 ft. 5 in. high, and can be placed in the 6-foot way without fouling the load gauge. The total weight is 1 200 pounds, and it can be quickly divided into three parts each capable of being handled by four men, thus enabling the machine to be loaded onto an ordinary platelayer's trolley for transport to site, where it can be unloaded and reassembled in a few minutes. Cost, about £295.

The motor driven portable grinder (fig. 15) is made by Messrs. Grimston, Pritchard and Plutte, Ltd., and consists of a 50-volt motor, driving by means of a flexible shaft an 8-inch diameter carborundum grinding wheel. Cost about £23.

Motor cars.

Petrol driven trolleys for carrying the ganger, gang and materials from place to place. The trolleys are supplied by various firms, principally :

D. Wickham and Company, Ltd., Ware, Herts.

The Buda Company, Harvey Works, Wembley, Middlesex.

Fairbanks, Morse and Company, Ltd., London, S. E. 1.

The inspection car for the ganger costs about £80 and the gang trolleys about £150.

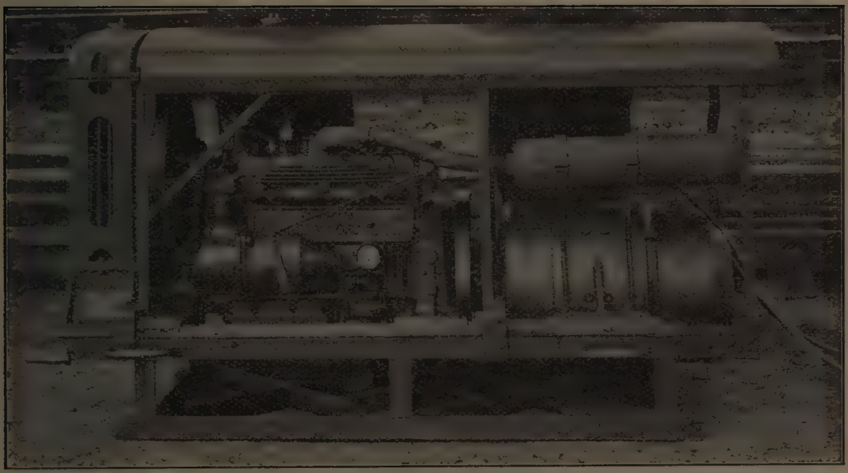


Fig. 14.

Fig. 15.

Miscellaneous mechanical tools.

Petrol driven drilling and rail cutting machines is a self-contained portable plant by means of which the drilling and cutting of rails can be expeditiously performed. It consists of a drill, separate petrol tank and a box containing accumulators and Delco-Remy coils for ignition purposes, with the necessary connecting leads and fuel supply tubes. The engine has two opposed cylinders with a total capacity of 104 c. c. and is capable of an output of nearly 4 B. H. P. Gears are provided to regulate the engine speed according to the size of drill in use and a clutch is of necessity provided. Cooling is carried out by the means of a small fan built into the centre of the flywheel, which delivers air on the cylinder head; there are also two supplementary fans, one over each cylinder. For outside use an open exhaust is used, but the firm can supply exhaust pipes and silencers for inside use. Control is by means of a « twist-grip » throttle lever. The machine is made so that it will take 1/2-inch to 1 1/4-inch drills, which can be used in any position. The drill complete costs about £60, and with railsaw attachment about £95, and is made by the Howard Pneumatic Engineering Company, Ltd., 25 Victoria Street, Westminster, London, S. W. 1, who can also supply a clamp for rail drilling fitted with a template for fishplate holes (cost about £6). A further accessory is that of a grinding unit by which an emery wheel is operated through an accelerating gear and flexible shaft (cost £30).

Electric drills and saws are used to some extent in connection with the framing up of crossing work before laying in.

Petrol driven screwing and boring machines are supplied by Messrs. The United States Metallic Packing Company, Ltd., of Bradford, and are being used experimentally in connection with boring sleepers and screwing in chair screws on the track. The machines are not used in relaying work, but in connection with the reconditioning of the track and for point and crossing work. Each machine consists of an 8-horsepower petrol engine, directly coupled to a dynamo, which, in turn, is capable of driving four electric boring or four electric screwing tools. The generating set can be handled by four men and is fitted with a grooved wheel at each end, thus enabling it to be run along one rail. The cost of the equipment is :

Generating set	£135
Two electric boring tools . .	£ 44
Two electric screwing tools .	£ 68
	£247

Cable 1 per 50-foot length for each tool.

Compressor plants are also used to some extent for boring and screwing in connection with crossing work.

Mechanical tampers.

Petrol driven compressor plants for mechanical tamping used experimentally, consists of an Ingersoll-Rand type « 20 » self-propelled gasoline engine driven tie tamper outfit (fig. 16) comprising vertical two cylinder single acting compressor driven by four-cylinder, four-cycle, tractor type petrol engine mounted on flanged wheels suitable for 4 ft. 8 1/2-inch track gauge, equipped with special lifting type cross trucks which enable the cars to be lifted without the use of jacks. Outfit also fitted with lifting bail which comes up through the top of the unit to permit of same being handled with locomotive crane, and is equipped with motor for self propelling along track.

Compressor cylinders, 9-inch diameter × 8-inch stroke.

Engine cylinders, 5 3/8-inch diameter × 6¼-inch stroke.

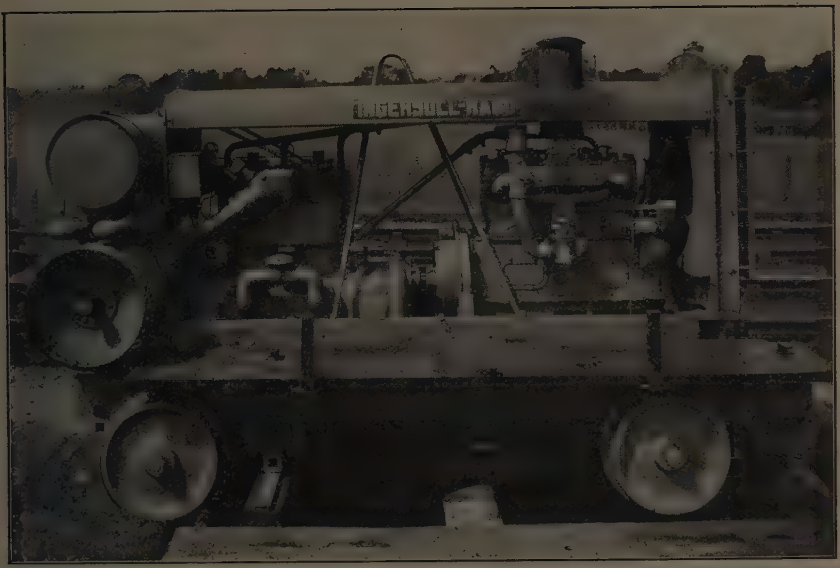


Fig. 16. — Compressed-air ballast packer. Air compressor. Great Western Railway, England.

Service conditions.

Compressor speeds . .	450 r. p. m.
Engine speed	1 150 r. p. m.
Piston displacement . .	265 cubic feet per m.
Air discharge pressure	100 lb. per sq. inch.

Twelve Ingersoll-Rand « MT-1 » tie tampers.

Six 100-ft. lengths of ¾-inch plain anti-peel hose with couplings.

Twelve 12½-ft. lengths ½-inch plain anti-peel hose with coupling.

Cost, about £1 250.

The experiment with Ingersoll-Rand 12-unit pneumatic tamping outfit consisted of the packing of four miles of track which was carried out in 35 days, giving an average of two minutes per sleeper. The number of men engaged was 15, consisting of the following :

1 ganger,
1 under ganger,
1 operator,
12 under men, including one look-out man.

The cost per sleeper including labor, petrol, oil, etc., came to 9d. each. If depreciation and interest on the cost of the outfit were included, the cost per sleeper would be increased to 10d. This does not include any amount for the cost of additional ballast. Figure 17 illustrates a gang at work equipped with a pneumatic tamping outfit.

Petrol-electric compressor plant for mechanical tamping as manufactured by

Fig. 17. — Compressed-air ballast packer gangs at work. Great Western Railway, England.

Messrs. Les Fils d'Albert Collet, of 41, rue Cardinet, Paris, France, was used in trial service on the southern area of the London & North Eastern Railway during 1930. The apparatus consists of electrically operated tamping hammers, arranged in groups of four, each group being driven by an electric motor. The four hammers are arranged so that both sides of the sleeper can be packed simultaneously both inside and outside the « four-foot » way. The method of working adopted is to pack both ends of the sleeper simultaneously. For this purpose, the two sets of four hammers with their two electric motors, are mounted on a small carriage which runs on the track. The action of a battery of eight hammers is stated by the makers to be equivalent to about 3 400 blows of about 180 pounds each in 20 seconds. The power absorbed by eight hammers is stated to be 4 400 watts. The weight of a battery of 8 hammers is about 1 200 pounds. Power is supplied by a petrol-electric generating set, having an output of 9 kw. It can supply two batteries of eight hammers each simultaneously. The petrol consumption is stated to be about 0.11 gallon per kw.-h. Handles and pneumatic-tyred wheels are fitted to the set to enable it to be wheeled along the side of the track. The weight of the set is about 900 pounds, and the dimensions are : length 63 inches, breadth 24 inches, height 43 1/2 inches. Cables consisting of two conductors convey the power to the tamping machines. During the tests a total of 6 003 sleepers were packed, representing about 2.84 miles of track, the work being carried out in conjunction with the relaying of the track, the mechanical tampers being used for packing the new track in place of the hand packing, normally employed. This particular machine was hired and taking the hire charge into account, the cost of the work was slightly higher than that of work done by hand under similar conditions. As re-

gards the quality of the work carried out by the machines, it was found to require the same amount of attention subsequently as similar track packed by hand, and no definite advantage could be credited to the mechanical packing.

Ballast equipment.

Petrol-driven ballast riddle is in experimental use, and consists of a 1 3/4 horsepower Villiers two-stroke petrol engine of the type used for light motor cycles, driving by means of a chain a vertical shaft, at the top of which is a cam connected to the underside of an inclined riddle. The movement of the riddle is semi-rotary, directly backwards and forwards at the low end, but having a circular movement at the elevated end, due to the action of the cam. A loose steel reversible container for collecting the waste material is fitted under the screen and this material can be either raked or shovelled out and thrown to waste. The clean stone is shaken off the end of the screen into a second steel container, somewhat like a scoop, which is provided to facilitate the work of the man who throws back the clean ballast — he is shovelling off a smooth steel surface instead of off the ground. The apparatus is mounted on a wooden frame and is hauled along the cess as work proceeds. The cost of the machine is about £20, and it is made by the railway company using it.

Fig. 18. — Portable ballast riddle.

Figure 18 shows the use of the ballast riddle in service.

Centre and side discharging hopper wagons for ballast distribution are used to advantage.

Either single or double ended ploughs are attached to brake vans accompanying ballast trains for the purpose of spreading the ballast after discharge and results in a labour saving in the final distribution and spreading of the ballast.

Rail wagons.

Rail wagons are, in a few cases, fitted with devices for the loading and un-

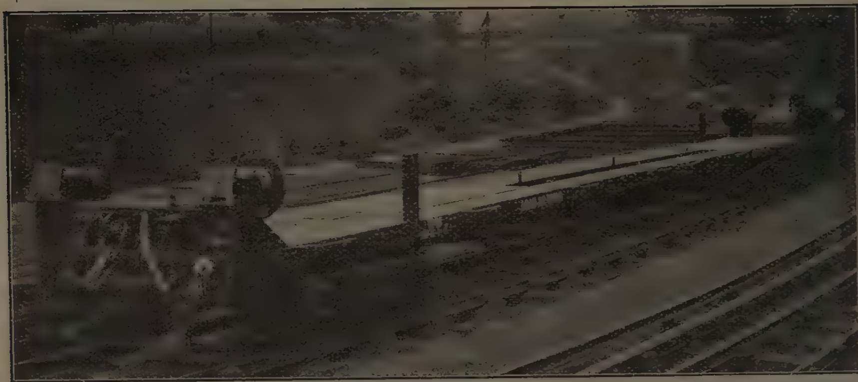


Fig. 19. — Rail wagon.

loading of rails. Due to restrictions imposed on the tube lines by the small structure gauge it has, until now, been necessary when taking rails down for rerailing to off-load them from the wagon at the nearest station to the work, the rails afterwards being loaded on to a trolley and taken to the actual site of the job. This method is necessary owing to the fact that there is not room in the running tunnels for the rails to be off-loaded over the side of the wagons. With a view of overcoming this double handling, it was decided, when designing the new wagons, to provide a slot in the deck of the wagons so that by means of swinging davits — mounted on the wagon — the rails could be off-loaded in the four-foot way between the negative current and one of the running rails at the actual site where they were to be installed. The wagons have been designed so that a rail up to 45 feet in length can be off-loaded in this manner. In addition, the overall length of the wagon will permit of rails up to 60 feet in length being carried, but in the case of rails of this length the previous method of off-loading will have to be worked to. The ballast trains when working on the District Railway are hauled by steam locomotives fitted with ordinary main line buffing and draw-gear. On the tube lines they are worked with electric motor cars which are equipped with the standard tube line type of tongue coupling. With a view of making the new rail wagons interchangeable for use on all lines the ends of the wagons have been specially designed to suit both types of motive power. When the wagons are being hauled by electric motor cars, the main line type of buffers are swung up out of the way. The wagons are designed to take a maximum paying load of 22 tons, and when required to carry ballast or other small material sideboards are fitted, but material of this description can only be loaded over the bogies. Figure 19 illustrates these wagons.

Dominions and Colonies.

Aside from Canada, which has been reported with North America, the Dominions and Colonies of Great Britain report very little, if any, use of mechanical appliances.

China and Japan.

The South Manchuria Railway of China reports the use of electric tie tampers, drills and pneumatic tie tampers on trial only.

The Japanese Government Railways report that mechanical appliances for the permanent way maintenance are not used generally. A few kinds of maintenance work, such as snow fighting, ballast loading and unloading, and tie tamping are performed by such means. They report snow fighting by the most modern mechanical means in general use and ballast loading and tie tamping in the stage of trial. An extensive test of several kinds of tie tampers has been made, the electric tampers being recognized as the most suited to their situation. The test of electric tampers on heavy traffic lines is being continued at present.

Motor cars are used extensively for the transportation of men and materials on the works.

Fig. 20. — General view of tie boring machine, Japanese Governement Railways.

Ties are commonly drilled by hand on the spot where they are to be used, but this operation, in some cases, is done by a tie boring machine (see fig. 20). Price, 300.00 yen. Maker, Watanabe Engineering Works, Tokyo, Japan.

This machine will drill cut-spike holes as well as screw-spike holes, and the drill is changeable for different size bits. The relative position of the bits is adjustable to meet the section of rail used and gauge. Further, the drills are so designed that the bits run idle when they reach the required depth. The machine, worked by two operators, will drill a tie in thirty seconds.

Electric tie tampers are used for the tamping of ties on certain lines. The source of power for the tie tampers used is 110 volts, 3 phase, A. C. This energy is obtained, on electrically operated lines, from transmission lines through transformers and for this purpose, switches are placed at every 100 m. (328 feet).

Price (including generator) . .	3 800 yen.
(excluding generator) . .	450 yen.

Maker Kusakabe and Co. Tokyo, Japan.

The automatic rail saw has been brought into service as a new device

for the cutting of rails. The engine of this machine saw is 3/4 H. P., 4-cycle and air cooling, and a 50-kgr. (101 lb. per yard) rail is cut in thirty minutes, while hand sawing of such a rail takes fifty to sixty minutes with two men engaged.

Organization of the work.

There is no special gang in charge of the mechanical maintenance, and the mechanical maintenance methods mentioned in the first part are being carried out by the ordinary forces.

[656. 254]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

XIIth SESSION (CAIRO, 1933).

QUESTION IX:

Automatic train control and train stop. Track equipment. Locomotive fittings. Methods used for repeating signals on the locomotives. Devices intended to ensure the attention of the drivers.

REPORT No. 2

(America, Great Britain, Dominions and Colonies, China and Japan),

by G. H. CROOK,

Assistant to Signal Engineer, Great Western Railway, England.

There has been a gradually increasing conviction, more particularly during the present century, that the already well developed methods of signalling by means of fixed signals alongside the track, operated under the governance of interlocking devices, telegraph communications, track appliances and track circuiting, are not entirely adequate in all cases to meet the demands of traffic conditions both from the point of view of safe and expeditious working.

Visual signalling systems, in which operated track side signals are seen by drivers from the locomotive, have reached an excellent stage of development, especially those which are controlled by insulated rail, track circuit or equivalent devices, also those subject to electric telegraph block control, of which there are numerous refinements.

A weakness in all these systems lies in the fact that however perfectly they may operate in themselves, difficulties arise in drivers obtaining satisfactory sighting of signals during conditions of bad visibility, such as heavy rain, snow, fog, etc., the last condition being perhaps the worst operating contingency railway transportation has to meet.

Many serious catastrophes have occurred during railway history due to signals having been missed under conditions of bad visibility. Among other adverse factors, the large boiler diameters of modern engines have not, in some instances, improved the engineman's view.

Emergency means for warning drivers during periods of bad visibility are employed, the most common being the placing on the rails of detonators, which are exploded by the passing of the engine over them. There are some objections to this method of warning, including the possibility of failure of a detonator to explode, which necessitates duplicate detonators being placed. Other equally serious objections are the difficulties of the signalman in determining

whether the density of fog, etc. demands emergency measures being introduced and the risk during the interval following the commencement of bad visibility and the arrival of the fogmen at their posts.

There is also the liability of the fogman meeting with accident while in the course of carrying out his duties, which might result in no fog signal being given.

Apart from acute periods of bad visibility, there are, with some systems of fixed signals two intervals per day, namely, at dawn and sunset when signals are more difficult to sight than in clear daylight or total darkness.

It is not, however, only during periods of bad visibility that serious accidents have occurred. In some instances atmospheric conditions have been so favourable as to render the cause of a particular accident inexplicable except for momentary mental aberration on the part of the driver or concentration upon some other duty at a vital moment, or possible temporary physical incapacity.

In spite of intensive training and well ordered discipline, the risk of accident due to failure in some degree of the human element is one that is ever present and means have been continually sought by railway managements and operators to overcome, or minimise this risk.

A typical serious train disaster occurred in England, in clear weather, in January 1931, involving loss of lives, and in this instance the distant signal was missed and the speed of the train was far in excess of that permissible for a low speed route which had been set. As a result the engine was derailed and part of the train wrecked. The Ministry of Transport Officer for Great Britain reported : « It is difficult to imagine a better illustration in support of the conclusion of the recent Committee upon Automatic Train Control. Had equipment of this kind existed, operating in conjunction with the distant signal, I think that this accident would have been prevented. »

It may be of particular interest to mention that in this case the train wrecked itself, without coming into contact with any other train.

The incident is simply quoted as being entirely typical of some previous disasters which have occurred, and from which probably very few countries in the world, with railway systems of any magnitude, have been entirely immune.

There have been many accidents in the past in various countries, and the opinion has been readily expressed by railway operators and others, that a large percentage of these would have been prevented had some system been in use for transmitting signals and/or effects to the locomotive.

A certain number of accidents of a particular class would not be expected to be preventable by these means, among which may be instanced collapse of bridges, structures, tunnels, permanent way (as by washaways) and other eventualities which are not normally detected by the signalling systems. On the other hand, it is amply clear that many accidents should be prevented by improved warning signals transmitted actually to the engine.

The term *Automatic train control* is rather a comprehensive one, and theoretically might include starting, acceleration, braking and complete stoppage of trains, thus largely superseding the driver's discretion. In the present stage of advancement the term usually implies rather less than this, and it is in practice restricted to the function of retarding or stopping trains independently of the observance of fixed signals on the track. Such devices can, however, hardly be considered entirely automatic when they co-operate with, or repeat track indications displayed in harmony with signals which are operated manually, and strictly train control can only

approach real automaticity when worked in conjunction with block signalling as by those systems using insulated rail or equivalent. The other terms of this question are self explanatory.

Question IX is restricted to automatic train control and like methods, but it may be advisable to note that in the present state many, if not most of these systems, are very intimately connected with, if not entirely dependent upon, the basis of the existing visual signalling systems using semaphores or other equivalent indicators with interlocking machines, and telegraph or other means of communication to ensure clear sections of track.

It is possible to eliminate visual track signals and rely upon engine signals and control for trains following one another in sections where exact stopping points have not to be enforced, but where junctions occur and trains must be definitely stopped short of certain fouling points, the problem of engine signalling is complicated, if not, at the present moment, impracticable. On this account, and for the excellent reason that it is good policy from the point of view of general safe working of trains to encourage the driver to keep a keen watch on his route, wherever this is possible, fixed track signals have (with few exceptions) been retained by administrations employing engine signalling, which latter is generally regarded as auxiliary to the former. There would seem to be some advantage in this, as failure of an engine equipment would not leave a driver entirely without signalling, and he would make the best possible use of the visual signalling, notwithstanding any limitations such as have been previously referred to.

The advantages claimed for the elimination of fixed track signals where automatic train control methods are used are that the expense of the line signals is saved, and that the chance of contradictory indications in the two systems is also avoided. The former is obviously true, but the reception of contradictory signals is an abnormal occurrence, and with properly designed systems should be so infrequent as not to be a serious objection.

Judging by the large majority of applications, railways using engine signalling still desire to retain fixed signals. Apart from the present technical difficulties in completely eliminating fixed track signals, there are many traditional and sentimental objections to such a course. It is, however, quite possible that with continued advancement of the technique of engine signalling, the tendency ultimately may be in the direction of eliminating at least certain fixed signals. I propose, therefore, to assume in considering this subject, that generally we shall think of the track signals as being retained, and the engine signalling will be auxiliary thereto, and with this assumption the question is inseparable from the problems of fixed signals on the track.

There are at least three (3) distinct types of fixed track signals :

1. *Distant warning signals,* the purpose of which is to give advance intimation of the position of succeeding signals;

2. *Home* or *stop signals,* the purpose of which is to bring a train to rest at a definite point. Such signals (as in the British system) may also combine the display of route information, and/or govern entrance into a block section;

3. *Shunting signals.*

The distant warning signal does not necessitate a stop at the signal. It may be passed at any safe high speed provided that, when the warning indication is shewn, the driver can exercise such control as will enable him to stop at the home signal. In view of the high speeds and heavy trains involved in present day transportation, this preliminary warning is a most important one, and without it trains could hardly be run expeditiously

and safely. The « clear » indication of the distant signal assures the driver that the home signal (or signals) is also clear, and on this indication depends the un-checked working of high speed trains.

We may note that there should be no great difficulty in associating engine signalling or control with the indications displayed by the distant signal. The distant signal is usually placed at a sufficiently remote point from the home signal for the highest speed of trains, so that if a signal is received on the engine when passing the distant signal, or if the brakes are applied as part of the same effects transmitted, there is sufficient space in which the train may be brought to rest without shock or unpleasant consequence.

It is possible to apply an automatic stopping device to home signals, but the dynamic conditions are entirely different. A certain space is necessary beyond the automatic stopping point before the train can be brought to rest and this space varies as a function of the speed at which the train is travelling (very approximately as the square of the speed coupled with corrections for grade and curvature, etc.). An extra clear length of line is therefore required to enable the automatic stop device to become effective if called into action.

In some installations of signalling certain stop signals govern movements up to the next stop signal while the line immediately in advance may be occupied, or fouled by switch movements, and the extra section is not therefore available. The only alternative in such a case appears to be some form of speed control while approaching the stop signal. This problem is, however, in general, much more complex than that of the distant warning signal.

Shunt signals apply to low speed movements, and they usually give no guarantee that the line is clear. Their main function is to assure the driver that the route is properly set and the switches secured. Shunts are frequently required to be made where lines are occupied and the length of the shunt is very variable. Train lengths vary, and so do stopping points, and the maximum of liberty has usually to be allowed in connection with these movements. It is thought that the automatic control of speed in the case of shunting movements is even more intricate than that of running line signals.

The problem of transmitting signals to moving trains has, for the reasons previously explained, come into much prominence during recent years, but it is not by any means a modern one. It would appear to have followed not far behind, or to have been concurrent with, some of the original conceptions of automatic signalling which started sometime about the middle of last century.

Prior to the development of the electric block telegraph and interlocking system of signalling, as we know it today, a brief examination of some early records seems to suggest that inventive effort of that period was largely directed to « Signalling and communications *between* trains ». Psychologically, if not practically, the early trend of signalling was perhaps even more automatic than is now the case, the aim being to effect signalling from one train to another direct instead of through the intervention of line signals and telegraphic devices. A little later the transition appears to have been in the direction of working signals either automatically or mechanically, still in most cases in association with some track device for control of the engine, and in some cases giving signals thereon.

Later still development of automatic signalling and engine signalling followed on rather more distinct lines.

Among these primitive proposals, levers, triggers and catches on the engine operated by chains, pulley, cords, inclined planes, etc. on the line, or electric

conducting wires or contacts on the line for ringing a bell or sounding the whistle on the engine seem to have been much favoured devices.

With no pretence to starting right at the commencement of railway signalling history, the following brief references to Bristish Patent Office specifications, are quoted for the sake of history, differentiation of types, curiosity and, not least, to denote the psychology of the period.

Guyard. 83/1855. — Continuous electric conductor with bell and battery on engine. « If another train comes within the distance to which the battery is capable of acting, a circuit is established between them and a signal bell rings on both—signals can be recorded on a sheet of paper moving at a known speed etc. The line wire may be divided into sections. »

Taylor. 399/1855. — A catch on the line displaces levers on the engine, which operating through chains blows the whistle, turns off the steam and allows a spring to screw on the brake.

Lackersteen. 26/1856. — Proposed the use of levers on track, depressed by a projection on the engine. The levers were connected hydraulically. When one is depressed, the preceding one is raised, engages with a lever on the engine and shuts off steam and applies the brake.

Baggs. 1775/1856. — Signals transmitted between trains by a line conductor using Leyden jars and rods from the train within sparking distance of the conductor. A spark is the signal of the proximity of a train.

Moore. 2573/1856. — A stump is raised by the passage of a train, causing the whistle of a following engine to sound *unless* the *time* interval *is sufficient for safety.* The stump is retained in the operating position for a suitable time by the gradual escape of fluid from a regulating vessel. (This is interesting as shewing the influence of the time-interval system of train working.)

Kendall. 3129/1857. — The signal post is provided with a horizontal spring arm projecting towards the rails to give a signal on the engine. (We may note this idea is for a cab signal co-operating with the line signal.)

Horwood. 448/1861. — Uses inclined iron bars (ramp) on track, and contacts and electro-magnetic needle indicator on engine. Current from the ramp actuates indicator which is provided with re-setting handle.

Kyle. 411/1862. — Proposed a train pipe full of compressed air whereby a whistle is continuously sounded. Interruption of sound by operation of valves by passengers, guards or external contacts on the line constitutes the signal.

Brae. 2007/1863. — Proposed a steam whistle weighted so that it tends to open but is normally held closed by the armature of an electro-magnet in a closed circuit which contains a battery and extends through the train. Switches were to be provided to open the circuit for giving a signal.

(*Note.* — This proposal applies to signalling on the train to the engine and not from the track, but is of interest because of the normally closed circuit.)

Balbi and Pommeral. 2130/1864. — Arranged to stop a train going in the wrong direction by a series of stops in the permanent way so as to act on a lever on the engine, shut off steam — and uncouple the engine from the train ! A bell was to be sounded on the engine on passing the stops, to indicate the distance travelled or for other purposes.

Clements. 3092/1866. — Proposed a miniature signal post, placed on the engine, the arms connected to levers acted upon by movable rails outside the metals. The movable rails were to be operated by the signalman and a continuous series were to be placed between the distance signal and station.

Moss. 3738/1868. — Proposed projections in the shape of double inclined planes which may be moved transversely between the rails, and the engine is provided with a central vertical rod projecting downwards and communicating

with the whistle and lever for cutting off steam.

Digney. 247/1873. — Provided for a steam whistle on the engine to have its valve controlled by a Hughes electro-magnet. A brush on the engine makes contact with a conductor on the track. When the « disc » signal is at danger, current is transmitted, the magnet deenergised and whistle valve opened.

Whyte. 1371-1874. — The semaphore is placed to danger by the engine wheel depressing a lever and it is latched up until released by an electro-magnet energised at signals in advance. A battery and bell are carried on the engine. When the signal is off there is no circuit but when the signal is at danger the bell is set ringing and the driver warned.

From these instances it will perhaps be appreciated that many of the elements of our modern systems were in a crude way anticipated a long while ago.

Apart from detailed methods of carrying out effects it may be said that there are two distinct schools of thought in regard to automatic train control. One school considers it sufficient to give a warning signal on the engine (and possibly a brake effect) in connection with the distant signal only, while the other school considers it equally important to give indications on the engine of stop signals, etc. In the opinion of others it may be considered desirable to transmit to the engine indications of both distant and stop signals. There are also further possibilities of giving warning indications at danger points, such as sharp curves or sections of line demanding speed reduction from various causes, which restrictions may be enforced by regulation quite independently of the normal signalling system.

Some of the methods which have been proposed or employed for transmission to the locomotive are :

1. Mechanical systems; trip arms on the track actuated by track signals and engaging with apparatus on the engine; ramps, either fixed or movable operating mechanical gear on the engine. These systems are by their nature intermittent systems, *i. e.* signals are only picked up at certain selected points.

2. Magnetic inductive systems which are almost inherently intermittent in character.

3. Track circuiting or other systems employing insulated rails or special rails.

4. Electrical systems involving contacts between track apparatus and the locomotives; contact with wires, rails, or ramps; high frequency inductive systems, transmitting current from conductors or rails to engines. Radio transmission. Some of these electric systems may be either intermittent or continuous.

5. Light or wave transmissions. Systems dependent upon the projection, or interruption, of a beam of light used in conjunction with sensitive electric receiving apparatus.

Excepting purely mechanical systems, devices are distinguished by being of intermittent or continuous character; in addition they may be of *contact* or *non-contact* type.

It is now proposed to consider briefly a few typical systems.

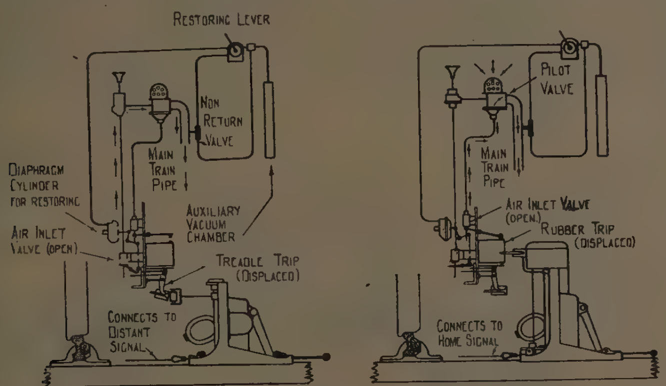
Mechanical sytems.

A good example of the degree of advancement under this heading is a system which was developed under the title of « Reliostop ». So far as the track is concerned it is purely mechanical, but strictly the engine apparatus is mechanico-pneumatic, as it involves the air brake system. This in fact, applies to many, if not most, systems and presumably the ultimate factor, pneumatic control, is so common as to be considered understood.

In one arrangement the engine carries

a mechanical treadle which may be pushed inwards, *i. e.* towards the engine, and a rubber trip, either of which may be displaced by track apparatus when in a certain operative condition. Figure 1 left hand shews the mechanical treadle being operated at the distant signal, and the right hand view shews the rubber trip being displaced at a home signal. The operations are differentiated in this way so as to give different brake applications, *i. e.* a partial application when the distant signal is at danger, and a full brake application in the event of the home or stop signal being over-run.

The complete action connecting the mechanical track gear working in conjunction with the signal, with the cab apparatus can be comprehended from the diagram of the pneumatic controls. The valves worked by the treadle or trip are normally closed. The left hand diagram



Distant signal.
Partial brake application.

Home signal.
Full brake application.

Fig. 1. — « Reliostop » — mechanical control devices for home and distant signals.

refers to the distant signal at warning; here the track arm engages the treadle, removes a trip bolt, opens the valve giving partial brake application admitting air into the train pipe, and sounds a siren. These effects continue until cancelled by the driver operating a restoring lever in the cab. This connects an auxiliary vacuum chamber with a diaphragm cylinder and by means of a bell-crank action releases the treadle to its original position and re-closes the air inlet valve. It may be noted that the distant warning if promptly cancelled is given without apparent loss of vacuum.

On the other hand the stop signal full brake application is irrevocable from the footplate. In this case if the track arm is in the operative position the rubber flap is displaced sideways and the valve lever is released with the consequence that the full brake valve is opened. The restoring lever is unconnected with this operation and the apparatus can be reset by the engineman only from the ground.

A point worthy of notice is the graduated design of the treadle for impact at high speed. A spring attachment can be provided on the track operating arm, so that engines setting back do not operate the treadle, the track arm moving instead. The apparatus has been in practical use on a British railway. It does not give a distinctive clear signal.

Train stop.

Another system which essentially involves a mechanical-pneumatic combination is that of a stop arm vertically engaging with a trip cock on the engine or train, and usually referred to as a train stop device (see fig. 2). It applies to home (stop) signals only and is a much favoured device on suburban electric railways. In some instances the trip arm has been mechanically connected to and worked in co-operation with mechanically operated semaphore signals. Since the beginning of this century, the tendency has been to provide automatic signalling controlled by track circuiting on such lines of intensive traffic, and the stop arm under these conditions is usually worked from a separate mechanism operated by electric motor, compressed air or other suitable agency, and co-acting with the signal, which in many modern installations would be a light signal. Once a signal is illegitimately passed the trip cock is moved and the brake application is irrevocable except from the ground. The design of these trip arms and stops is satisfactory for the speeds encountered, but there always has been doubt as to their suitability for very high speeds.

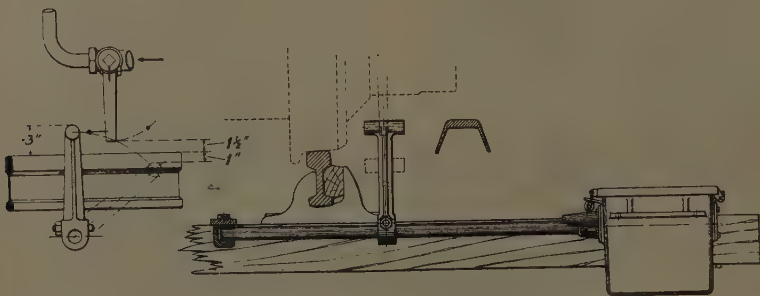


Fig. 2. — Train stop and trip, electrically operated.

It may be noted that except in the case of error on the part of the driver, or failure of the mechanism, the trip arm should never come into contact with the track stop; that an extra clear section must be provided in which to bring the train to rest in the event of the signal being over-run; also that no separate indication of the train stop in the clear position is given on the engine. It is, however, usually arranged that the signal shall not shew « clear » unless the track stop is first lowered to the clear position. The device is an invaluable safeguard and without it the operation of trains by one man only would be much prejudiced.

Various arrangements are in force for detecting the existence of the track stop, including co-operation with the associated signal, and in some instances also the next signal in the rear.

Auxiliary to the trip arm on the train, it is very common practice to instal a device known as the « deadman's handle », which provides for pneumatic control of the traction current where electric trains are driven and controlled by one man only.

When the controller is set in either forward or reverse driving positions the train pipe would be open to atmosphere

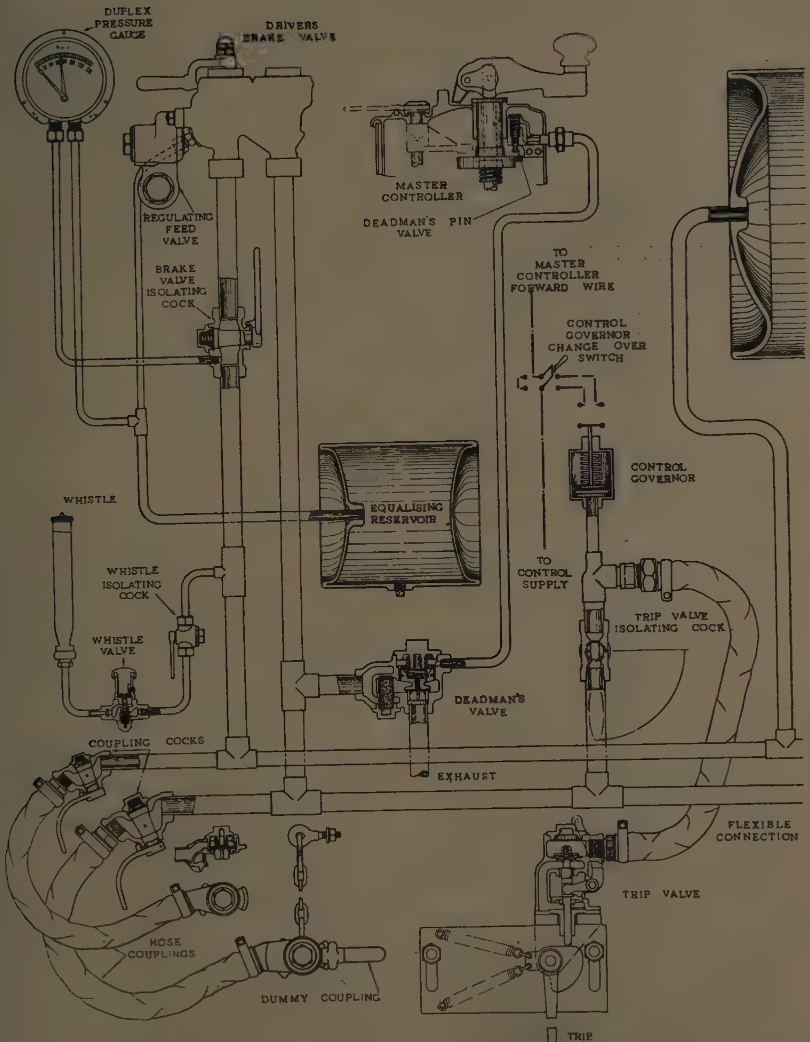
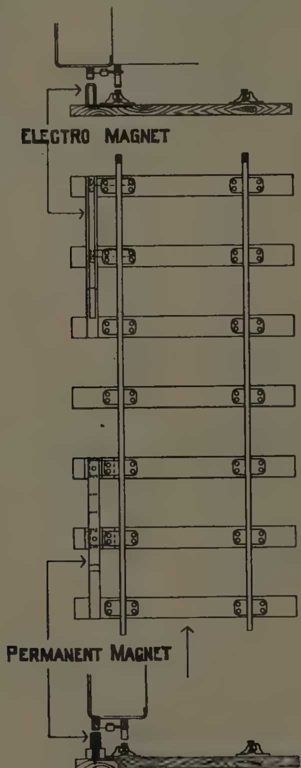


Fig. 3. — Deadman's handle, controlling electric traction current and brakles.

and the brake become effective unless the « deadman's handle » is kept depressed all the while, thus closing a small valve which controls a relay valve in the train pipe. The primary object of this function is to enforce sentient operation by the driver — to ensure, as far as may be, that the electric current for driving the train cannot be applied with the driver incapacitated. Like many other devices for affording safety, it is perhaps not absolutely fool-proof nor immune from wilfully bad misuse, but it is a valuable device.



A pneumatic control governor in close association with the trip device ensures that sufficient air pressure (or vacuum) for brake operation is available before the current supply is completed. In emergency the trip device may have to be isolated from the train pipe and the current control circuit can then be regained by moving a change-over switch which is normally sealed.

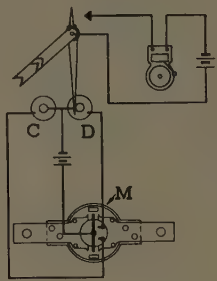


Fig. 4. — Boult's magnetic system of cab signalling.

A typical scheme of these arrangements is shewn by figure 3, which applies to the pressure system of air brake.

Magnetic systems.

In systems which depend upon electrical contact between stationary and moving parts, there is risk that dirt, rust, snow, ice, etc. on the apparatus may prevent the transmission of current and signals to the engine apparatus. In 1893 Boult sought to overcome these limitations by operating engine signals through magnetic induction, thus avoiding the necessity for contact both mechanical and electrical (fig. 4). The scheme involved the provision on the permanent way of permanent magnets succeeded by electro magnets, the latter being energised only for the clear signal. On the engine were soft iron polar extensions,

which when inductively magnetised in passing over the track magnets were arranged to deflect armatures which in turn completed the circuits of indicators. In a typical arrangement miniature semaphores worked by an electro-magnet and battery on the engine were used, and a contact on the miniature semaphore when in the danger position caused a bell to sound.

The system was contactless so far as the track and engine relationship was concerned, but contacts were necessary on the engine for sounding the danger signal. No very distinctive clear signal was given. The system was in experimental use on the Great Northern and Great Central Railways of England, and operated successfully, it is understood, at very high speeds. It may be noted that since this period great improvements in the production of permanent magnets have become available.

A recent development of the magnetic induction principle is that known as the Strowger-Hudd, and which is in experimental use on the Southern Railway, England. The broad features of transmission from track to train remain as in the Boult system above referred to, but instead of the magnetically influenced apparatus on the locomotive operating circuit-closers for ringing a bell as in the Boult system, it operates the air (vacuum) brake system direct and sounds a hooter.

The track equipment consists of inductors arranged centrally between the running rails. Type « A » employs permanent magnets only, arranged at right angles to the rails, which when passed over operate an accoustic danger signal and brakes. Inductor « B » consists of an electro-magnet laid parallel with the rails and is capable of cancelling the former signals. These two inductors are applicable to single distant signals and are placed some little distance apart, say, 200 feet. Another arrangement designated inductor type « C » for use at home signals, is a combination of the two preceding types. The electro-magnet is energised only when the signal is clear.

The diagrammatic illustration (fig. 5) of the receiving apparatus on the engine shews four collector plates terminating in pole pieces. Pairs « A » collect magnetic flux from the permanent magnets arranged transversely with the track and the other pair of plates collect magnetic flux from the permanent magnet laid longitudinally. Pivoted between these poles is an armature « C » with an extension which normally covers and keeps closed a pilot valve « F » connected with and actuating the brake control valve « L »; when this valve is opened air enters the train pipe and operates the hooter.

When the engine receiver passes over the permanent magnet inductor on approach to a distant signal, poles « A » are inductively energised and the armature opens the pilot valve and gives the danger signal. Assuming the signal is at danger no further effect is produced on passing it, hence if the driver takes no action the hooter continues to sound and the brake application will ultimately bring the train to rest before reaching the home signal. However, an acknowledging plunger is provided and by means of temporary reduction of air pressure created by operation of the plunger, the armature and pilot valve can be restored and the hooter stopped from sounding. To check misuse of this acknowledging or cancelling plunger a speed control centrifugal device operated by an axle has been proposed and unless the speed is reduced to some reasonably low pre-determined figure, say 20/30 m. p. h., the plunger pipe is open and cancelling ineffective. If after receiving a signal at inductor « A » the distant signal is clear, inductor « B » (electro-magnet) is energised and thus by means of magnetic influence through poles « B » resets the armature to its

normal position. In this case only a short hoot results. The receiver is 5″ and the inductor 1″ above rail level and there is therefore a very safe clearance between these parts, also between the receiver and other track gear, such as level crossings, etc. It can be arranged for the electro-magnet to consume current for a very brief period only by providing a section of insulated rail (track circuit), but this is more or less applicable to most systems. We might notice that

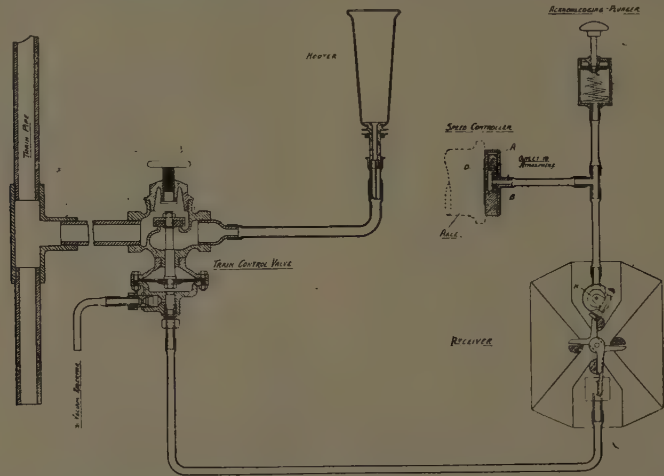


Fig. 5. — Strowger-Hudd magnetic-pneumatic system. Diagrammatic scheme of receiver apparatus.

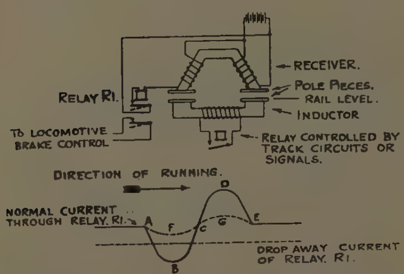


Fig. 6. — G. R. S. intermittent-inductive auto-manual system. Diagrammatic scheme of engine apparatus and track inductor.

the same hooter sounds both for danger and clear signals, the only difference being time of duration and there is really no distinctive clear signal. The distance between inductors is fixed and the length of time the hooter sounds is therefore proportional to speed. At 60 m. p. h. it would be about two seconds. One other important feature in addition to the non-contact design is that there is no electrical apparatus whatever on the locomotive.

G. R. S. intermittent inductive auto-manual.

Another system utilising the principle of magnetic induction is the General Railway Signal Company's intermittent inductive auto-manual (fig. 6). It is a non-contact system and may be applied to automatic or manually operated block systems. About 6 100 track miles of this

system are in use in America. The transmission arrangements between track and locomotive employ a receiver on the locomotive consisting of an inverted U-shaped electro-magnet with laminated cores, large pole pieces and two coils. The other element called an inductor consists of a U-shaped magnet with pole pieces of the same size and shape as the poles of the receiver.

The track inductor is secured on special ties (sleepers) with its pole faces 2 1/2 inches above the running rail, and about 20 inches from gauge line. The receiver is placed on the locomotive so that when passing over the inductor there is a clearance of about 2 inches. One of the two coils of the receiver (called the primary coil) is constantly energised from a source of energy on the locomotive, and produces a strong magnetic field. The other coil of the receiver (called the secondary) is connected to the same source of energy and includes a relay which normally operates in the closed position through one of its own contacts.

Certain track inductors are provided with a choke coil and which is controlled through the signal system in such a manner that when a speed restricting impulse is to be given the coil is on open circuit, and when no impulse is to be given, the coil is closed on itself. Certain other inductors which are required to transmit no other than a speed restricting impulse have no choke coil. These act in exactly the same way as a wound inductor with its coil on open circuit.

When the engine receiver passes over an inductor in the clear signal condition, the closed choke coil tends to resist change of flux, both in the inductor and engine receiver and the change of flux in the receiver is insufficient to operate the relay. If the danger signal is to be given, the track inductor choke coil is on open circuit and when the engine receiver passes over the inductor there is sufficient change of flux to set up an induced current of adequate strength in opposition to the permanent current. During this momentary change the relay is de-energised and being a « stick » (or disengaging) relay it remains de-energised until the driver's acknowledgment is made. The relay in turn actuates a brake valve. No separate clear signal is given.

The diagram (fig. 6) illustrates the schematic arrangement of track inductor and receiver, and also the effect of the induced impulse through the relay. Curve ABCDE illustrates how the normal battery current through the relay would be varied as a result of a receiver passing an inductor on open circuit (assuming

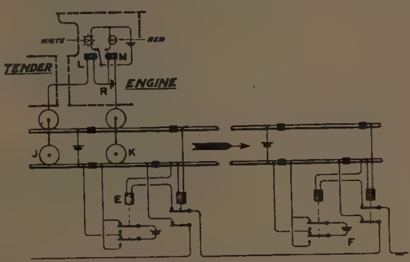


Fig. 7. — A cab signalling system using track circuiting (Miller system).

the relay was not controlled through its own contact). Curve AFCGE shews how the normal current through the relay would vary when the receiver passes an inductor on closed circuit, as would be the case under clear signalling conditions. The reduced amplitude of the wave form as the resulting effect of the choke coil is insufficient to reduce the relay current below that which will allow its contact to open.

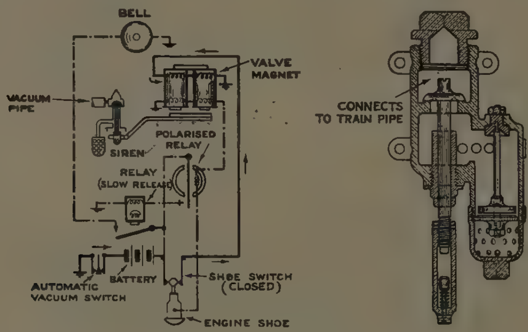
Track circuit systems.

A system was in use in America some years ago employing continuous track circuiting (fig. 7). Engine signals were

given by the lighting of red (danger) and white (clear) electric lamps. At the commencement of each block section a separate short portion of insulated track was specially provided for giving the engine signals. The engine and tender were electrically insulated from one another, and when the engine passed on the short insulated section with the tender on the other section, the effect could be transmitted. The system is merely mentioned because of its interesting type. A possible criticism is that special short track circuiting sections are not considered desirable. Systems have since been developed giving continuous indications on the engine in which track circuit control is involved, but without introducing special short sections. Some of these will be described later.

Electro-mechanical systems.

Systems of this class are almost inherently of the intermittent contact type, that is, signals are transmitted at select-



Normal. *Valve detail.*

Fig. 8. — Great Western Railway system. Diagram of engine wiring sherving normal circuits, and valve detail.

ed points and mechanical contact at varying speeds is involved. One such typical system is that which has been developed by and is known as the « Great Western » (England). The system is now in extensive use on about 2 538 engines, and 2 204 miles of track with 1 653 signalling points are equipped.

The aim of the system is to give in the cab of the locomotive audible signals corresponding with the indications of the distant signal, and in the event of the warning signal being disregarded to apply the brake automatically and bring the train to rest at or before reaching the home signal. No attempt has been made to apply the system to home or stop signals.

The apparatus consists of three main parts :

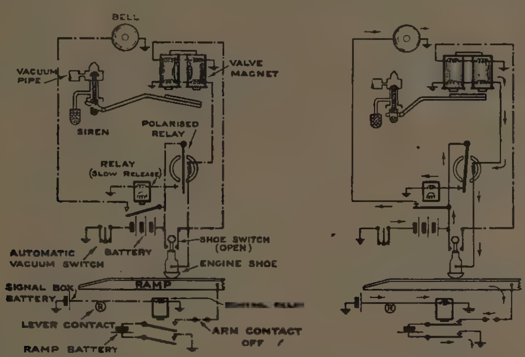
1. A receiving apparatus in the cab, capable of sounding a siren and automatically applying the brake when the distant signal indicates warning, or ringing an electric bell when the signal is clear.

2. A plunger fixed beneath the engine operating an electrical switch and capable of a vertical lift when coming in contact with the inclined portion of

3. A fixed ramp in the centre of the

track. The ramp is formed of T section bar mounted on a timber baulk which acts as an insulator, the metal bar being connected electrically to a battery when the distant signal is worked to the clear position.

The engine apparatus (fig. 8) works on the closed circuit principle and while in use current from a local battery carried on the locomotive is continuously flowing through the plunger switch and valve electro-magnet which when thus energised, by means of a lever attachment keeps the air inlet to the siren and brake closed. When the engine passes over an un-energised ramp (warning) (fig. 9), the plunger is lifted, the closed circuit momentarily destroyed, causing the armature of the valve magnet to fall away, and producing the warning signal and automatic brake application. When the plunger passes off the ramp, energy is restored to the valve magnet, but this is insufficient to pick up the armature by attraction. The warning effect can,



Caution signal. *Clear signal.*

Fig. 9. — Great Western Railway system. Diagram of wiring for *caution* and *clear* signals.

however, be cancelled, or even forestalled, by means of a restoring lever, and when the armature is mechanically lifted into position again the energised electro-magnet retains it and keeps the valve closed.

When it is desired to transmit a clear signal (fig. 9), the distant signal lever closes an electric contact in the signal box and connects a battery to the control line. Current then passes through a contact operated by the distant arm in the clear position to work a relay, which in turn connects a battery of about 16 volts to ramp on one side, and to rail on the other. The plunger is lifted and opens the engine circuit as before, but an alternative circuit is set up from the now energised ramp through a second winding on the electro-magnet to the mass of engine and rail, and current flowing thereby keeps the valve closed. The warning signal is therefore suppressed. In addition, the ramp current passes through a quick-acting polarised relay, and this relay, through its contact, completes the circuit of another relay, known as a slow-release relay, which, when energised by a momentary impulse, completes a circuit and rings an electric bell for a period of one to two seconds. The object of the slow-release

relay is to prolong, so to speak, the effective duration of contact between the plunger and the ramp. This occurs for approximately 25 feet only at 75 m. p. h. which represents less than 1/4 second.

The gradient of the ramp (fig.10) rises from rail level to 3 1/2 inches above rail level and the normal position of the plunger is 2 1/2 inches above rail. In passing over the ramp the plunger is therefore raised 1 inch. A lift of 1/4 inch is required before the circuit is broken. The ramp has a total length of 44 ft. 3 in. and under normal adjustments contact is established for 25 ft. 8 in. and the valve magnet circuit is open for 22 ft. 9 in. The diagram attempts to illustrate how the contact with the energised ramp overlaps the valve opening and suppresses the warning

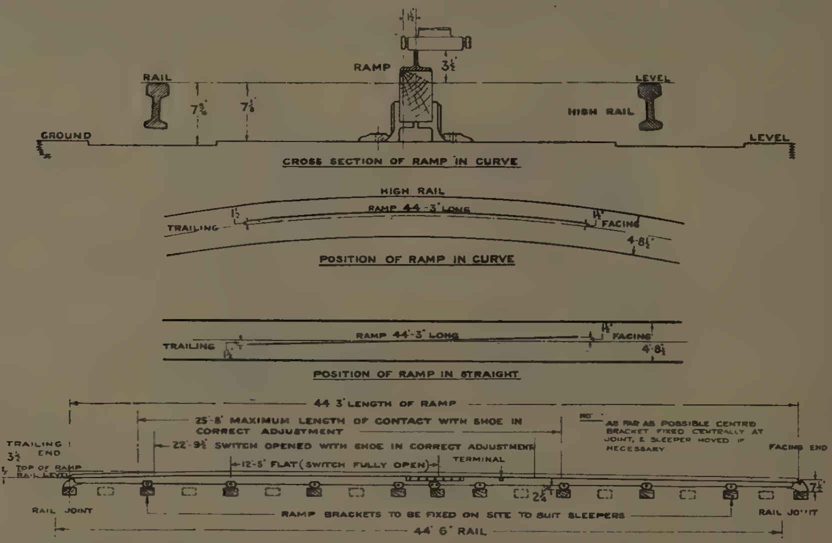


Fig. 10. — Great Western system. Details of ramp.

signal. Incidentally it may be interesting to note that 22 ft. 9 in. at 90 m. p. h. represents an operating period of only one sixth of a second during which the local circuit is open, but this is quite effective in de-energising the valve magnet. In practice various tolerances have to be faced, for instance, with a high plunger shoe or worn ramp the period of opening may be slightly less. An interesting point is that the plunger, although spring loaded, does not suddenly drop when passing off the highest point of the ramp, and if the descending slope is made too abrupt, at very high speeds, the plunger breaks contact with the ramp for several feet. In fact the plunger possesses all the characteristics of a moving projectile and conforms to its trajectory. This fact had to be recognised in designing the ramp gradient.

The system is applicable to single lines on which the ramp for a distant warning in one direction becomes inapplicable in the reverse direction of running. This condition has been met by energising

the inapplicable ramp with positive instead of the usual negative current. A polarised relay is introduced on the engine and whichever way this operates it suppresses the danger signal, but positive current does not ring the bell. The ramp is thus reduced to what is known as a neutral state and which condition may be controlled by the single line electric block token or other system in operation for controlling the signalling.

The system was first introduced on the Henley branch of double line in 1906 and in the same year on the single line Fairford branch, in which instance the fixed distant signals were abolished, the warnings then depending entirely upon the engine signals. In 1908 some 18 miles of 4-road track between Slough and Reading were equipped, which enabled the system to be continuously tested, at very high speeds. In these early installations the whistle was blown by steam, and audible signals alone were arranged. In all the later installations the whistle or siren was worked from the air system and at the same time an automatic brake application was arranged, as previously described. Also in the early equipments when the whistle sounded the word « danger » appeared in an indicator and the bell continued ringing until acknowledged by the driver. The visual indication of « danger » has now been omitted and the addition of the slow release relay giving a short ring for about one second, has obviated the necessity for acknowledgment as each clear signal is passed.

The standard position of the ramp on the Great Western is 440 yards before reaching single arm distant signals, the original idea being to give the driver the automatic warning at the point at which the distant signal may be expected to be sighted. In the case of combined home and distant signals it appeared to be somewhat contradictory to give a warning signal while approaching the home signal shewing the clear indication, notwithstanding that the distant signal was indicating «warning», and the ramp is therefore provided at the signal. These are the two principle positions of the ramps in relation to signals, but on account of complications at some stations and junctions small variations and compromises have sometimes to be made, in some cases the ramp being placed in advance of the signal. When water troughs occur for the purpose of enabling the locomotive while in motion to gather water it is the practice to place the ramps reasonably clear of the water troughs so as to afford the driver ample space in which to set down or pick up the water collecting apparatus.

Some of the principal technical claims for the Great Western system are that there is no movable apparatus on the track and that the permanent current in the engine apparatus renders the system self-detecting against failure. The tendency of all failures is to give the warning signal and even if this is not intended it is an error on the side of safety. The danger signal does not depend upon contact and the reception of electrical current. The system may be applied to manually operated or automatic block systems.

A modified arrangement of the system was produced by the Great Western as long ago as 1908, in which the permanent current on the locomotive was avoided. The rise of the plunger was arranged to exert tension on a steel wire, rotate a drum and open the whistle valve. If, however, current was received from the ramp the rotation of the drum was ineffective to open the valve, but a relay was caused to ring the bell as described in the standard apparatus. The arrangement has not been in practical use. Other somewhat similar modifications with the same object have been produced by Sykes (electro-mechanical) and Berry and Moore (electro-pneumatic).

Continuous indication, inductive systems.

The systems so far considered are of intermittent character, in which engine signals are given at selected points only. In this respect such systems are somewhat more limited than visual systems in clear weather, as in these visual systems the signal is often visible over a long range while approaching it and during this continued period of visibility, if the signal should change to a more favourable or less restrictive indication, the driver can at once take advantage of the knowledge without waiting until the signal is reached. No intermittent system can really copy this effect, and an ideal which has been pursued by some authorities is the production of a continuous indication on the engine, shewing the state of the line in advance, or indications which shall denote safe speed of travel.

It is conceivable that a continuous indication might be transmitted by means of a conducting wire or wires with collectors on the engine. There would be many objections to such a method, for

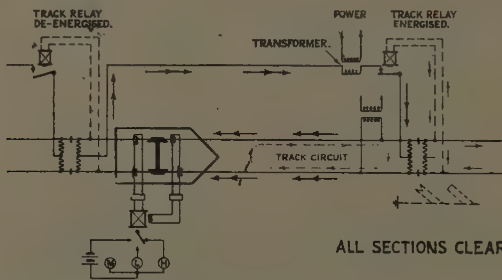


Fig. 11. — U. S. S. 3-speed continuous inductive system. Simplified circuits of 2-aspect (home and distant) signalling.

instance, inconstancy of relationship, and wear and tear. Non-contact methods have therefore been sought and an arrangement known as Railophone invented by von Kramer was tried some years ago. Its object was telegraphy, telephony or signalling to a moving train, and it required a continuous insulated conductor along the track and receiving coils on the engine, the effects being transmitted by induction currents. To obtain consistent transmission results the conductor shoud be kept at a reasonably constant distance from the track concerned (which may not always be easy or practicable). On the other hand the relation of the train to the track is obviously intimate and constant and there is from this point of view considerable advantage in using the track rails for the transmission of indications to the engine.

U. S. S. 3-speed continuous inductive.

This system is designed to be applicable to three-aspect signalling but for simplicity we shall consider it in the first place as operating two indications only, as would be the case if two aspect signals were indicated.

As illustrated (fig. 11), we have alternating current track circuits and the currents in these circuits are represented by single arrows — up one rail and down the other in cyclic order. Then there is superimposed another order of alternating current split through balanced

resistances and connected with the track rails; thus the divided portions of this current are of equal value and flow in the same direction along the rails as indicated by the double arrows. Electrical pressure at all opposite points along the rails is equal and there is no tendency for the control current to flow through the track apparatus. Similarly the middle points of the resistances are null points and the track circuit current cannot flow through the control circuit which is completed by means of an insulated conductor, the physical relationship of which to the track rails is not very material.

Supposing all sections are clear and the train approaches the signal in the full clear position. The engine has two receiver coils inductively placed as regards the rails, one of these coils being at the leading end and the other at the trailing end, and these are connected by means of thermionic valve amplifiers to a three-position relay. This illustration only concerns two positions of the relay. The trailing coils are arranged to pick up the control current (double headed arrows) and the intervention of the axles has no effect on this reception. This control current detects the section in advance of the signal to be clear for any desired extent or length. The leading coils pick up the track circuit current (inductively), but if there should be a train ahead this section of track circuit will be short circuited, and there will be no track circuit current received. The operation of the relay requires the combined effect of track circuit and control current and hence detects the section clear right from the train itself up to the clearing point of the section in advance. The relay armature as shewn is swung over to a contact lighting a lamp « H » which permits high speed. A section

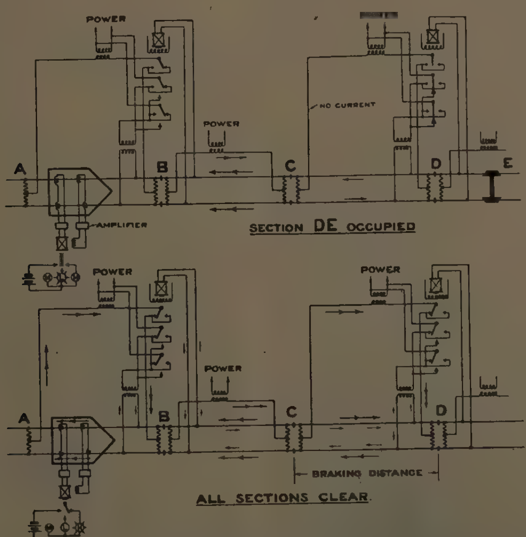


Fig. 12. — U. S. S. 3-speed continuous inductive system. Polarised controls for 3-aspect signalling.

ahead occupied de-energises the relay and changes its contact to the « L » lamp, indicating low speed. By means of such a relay, obviously brake control also can be effected. In three-aspect practice another lamp « M » for medium speed is also used which might require only one section clear. The high speed lamp would require at least two sections clear. The differential action of the relay corresponding with one or two sections clear may be obtained by polarised control of the track circuits (or other means) and figure 12 explains this. In the instance where a train is occupying a section the control conductor circuit is opened and there is no control current applied to the rails, also by comparison with the case where all track sections are clear it will be observed that the track circuit current is reversed in direction and due to this reversal the « H » high speed indication is changed to « M », medium speed indication. When the train comes within braking distance of the stop signal, the « M » indication would be further changed to « L » low speed indication.

U. S. S. 4-code continuous inductive.

The three-position relay used in the last scheme can only produce a maximum of three indications, whereas some lines were already using what might be termed 4-aspect signals, and to meet this, a modified system, still using induction currents from the rails was developed (fig. 13). Commercial power supply is usually of alternating current of frequencies from 25 to 60 cycles per second, and to eliminate any possible interference the train control operates on alternating current at 100 cycles per second. This control current is transmitted in pulsations of 180, 120, 80 or zero waves per minute and resonated apparatus on the engine is selectively operated by one or other of these particular alternating-pulsating currents, whence the name « 4-code » under which the system is known. The actual signals on the engine are in the form of small electric light signals, and in fact duplicate exactly the aspects shewn by the wayside signals. In America where the 4-code system is used, the system of signalling is fundamentally by speed indication and the complicated junction aspects, which

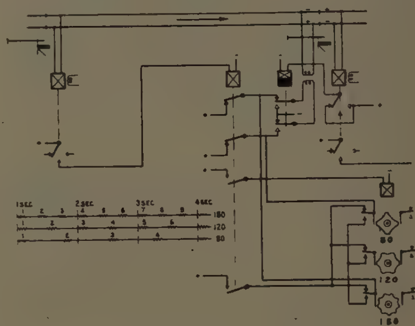


Fig. 13. — U. S. S. 4-code continuous inductive system. Transmission apparatus.

involve so many geographical variations and which would require an almost unlimited code to repeat, are avoided. The code transmission is performed by cam-operated circuit contactors driven by miniature induction motors started up by the de-energised track relay at the entering end. An idea of these groups of waves is graphically shewn. In every period of three seconds, we can have 9 or 6 or 4 interruptions of the 100-cycle per second current and these ratios are sufficiently distinctive to enable relays on the engine to be tuned to respond. That this tuning is possible will be readily appreciated from the analogy of radio reception.

The application of the code is :

Indication.	Interruptions of 100-cycle current.	Pulsations per second.
Clear	180 per minute.	3
Approach restriction.	120 —	2
Approach	80 —	1 1/3
Caution—Slow speed.	Steady current or no c rrent.	...

Receiving coils are carried by the engine just ahead of the leading wheels, with a minimum clearance of 4 inches from rail (fig. 14). The coded current is inductively picked up and by means of thermionic valve amplifiers operates a master relay, in groups of vibrations of 3, 2 or 1 1/3 per second by virtue of increase or decrease in the plate current. In so vibrating, the master relay connects direct current to a transformer, the secondary of which supplies current simultaneously to the three decoding relays. These relays are connected to tuned circuits, comprising condensers, inductances and rectifiers, thus providing for selection. In this way any one of the code currents only operates the appropriate relay : A (180), R (120) or L (80). These relays in turn control the lighting

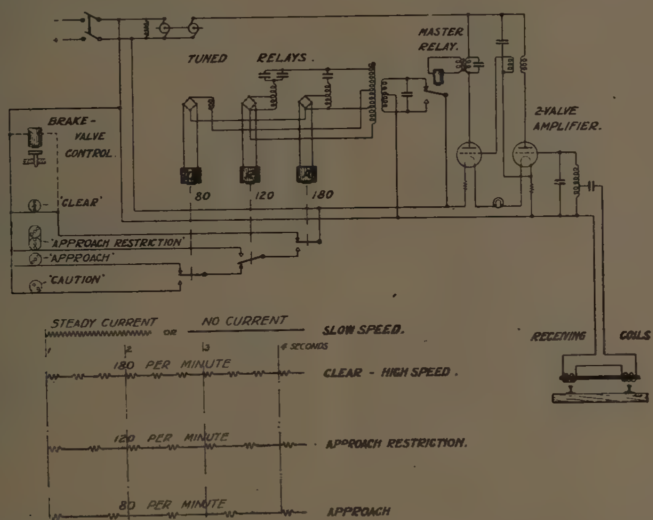


Fig. 14. — U. S. S. 4-code continuous inductive system. Receiving apparatus.

of miniature lamp signals. The slow speed indication is given by all three relays de-energised, and the other three indications by one or other of the three relays energised by coded current. Immediately one of these relays is de-energised a brake application is initiated. A timing valve commences to operate and sounds a small warning whistle, and if the change to a more restrictive indication is not acknowledged within about six seconds the brake is applied. Following such an automatic train stop — due to failure to promptly acknowledge, the normal operation of the system can only be resumed by bringing the train to rest and operating a resetting switch from the ground. If the warning is promptly acknowledged, that is, within the time allowed, the brake valve control is transferred to the relay control of the more restrictive indication, which then becomes continuously operative, and thus there is then no interference with the driver's liberty and responsibility.

There are other interesting systems in operation, many in America, and some on the European Continent, which latter, it is presumed, will be described by the contemporary Reporters.

Driverless trains.

It has been said that the future of railways lies in driverless trains.

Remembering that there are numerous and extremely varied conditions to be met in practical railway operation, such as allowances for loads, grades, curves, speeds and brake power, it is certain that many intermediate stages of development must be encountered and overcome before this so-called ideal may be gained. Such schemes would seem to inevitably require for their fruition some motive power other than that of coal and steam — a power agency readily adaptable to control from a distance, as for instance, electricty.

With the help of all appliances known to engineers, such as track circuits for denoting the exact position of trains, methods of operating and indicating the position of remote points (switches) coupled with some form of control of motive power and brakes, it is conceivable that a single operator might without the intermediary of line signals and engine drivers, directly manipulate many trains in a large area.

It is perhaps right to say that when this stage is reached the complexity of mechanisms will have increased for which human brains and hands will yet be required, so that we shall not have entirely displaced the human element but utilised it less directly. Whether this would be for good or ill is purely a matter of speculation.

It would, however, realise what would be practically and literally « Automatic train control », and as shewing that this attainment is not utterly impracticable the Post Office Tube Railway, of London, is instanced, of which the following abridgement of a description may be of interest.

The railway was completed in December 1927, its purpose being the transportation of letters and parcels. Passengers are *not* conveyed. The railway is 6 1/2 miles long with a total of eight stations. The gauge is 2 feet. Double tracks are carried in tunnels of 9 feet diameter, branching into 25-foot tunnels at stations.

Platforms vary from 90 to 313 feet in length. At the ends of each station the tracks are graded about 1 in 20 for a short distance to assist the starting and braking of trains. The running rails are of flat bottomed section, 35 lb. per yard on oak sleepers.

The tractive power and control is electricity, the primary supply being 3-phase, 6 600 volts, 50 cycles. At electrical substations this is converted to 440 volts direct current and distributed to each station along the route and thence applied to a third (conductor) rail through contactors. The 440-volt direct current is also converted at each station to 150-volt direct current for traction purposes on certain sections of line. The return traction current is by means of one of the running rails bonded to a copper conductor.

Each steel car, weighing 2 1/2 tons empty, is 13 ft. 6 in. long and is provided with two 22-H. P. electric motors connected in parallel. A permanent resistance of about 8 ohms is in series with each motor, so as to provide a safe limit upon the starting current, and there is no further control apparatus on the car. Part of the permanent resistance is provided in the windings of the selenoid-operated brake magnets. The brakes are normally on the wheels, but when current passes the solenoid removes the brakes against spring pressure. A reversing switch is provided on each car to enable it to run in either direction.

Two collector shoes are fitted to each

car and cable couplers enable cars to be joined to form a train.

The trains are energised in the ordinary way from the conductor rail which is divided up into sections. Starting from a station platform berth, that section is usually energised at 440 volts in order to give quick acceleration to the train. The latter may then pass over a section at 150 volts to clear crossings, etc., and then on to a main line automatic section at 440 volts. A speed of about 35 miles per hour is quickly reached and maintained over the automatic sections until approaching the next station. The up gradient is then de-energised and the train comes to a standstill at the top of the slope just outside the station. A few seconds halt is allowed as a margin to ensure that the train has actually stopped, and the section on which the train is standing is then energised through a cam shaft control first at 440 volts for a quick start and then at 150 volts to give a speed of about 8 miles per hour, at which speed, or less, the train enters the station. If it is a stopping train it runs on to the platform berth, which is dead, and is promptly pulled up by application of the brakes.

In the switch cabins the control levers are arranged in a locking frame, in which all movements of levers are controlled mechanically and electrically. The system of control is an adaptation of the « route lever » principle by means of which one lever movement sets up the complete route including any number of points involved.

Many refinements are associated with the operation, such as track-circuiting, indicating, and train-describing apparatus. In some sections the application of traction current is controlled automatically, dependent upon whether advance sections are clear or occupied. In the vicinity of stations the traction current is also controlled by the interlocking machine, which in turn sets the routes.

As part of the general equipment there are also chutes, conveyors and elevators, for taking matter to and extracting it from the trains.

It is impossible more than briefly to touch upon so interesting a system, and it would indeed seem to be rather beyond the limits of this question, but is nevertheless an example of advanced automaticity in transportation and perhaps one of the logical developments of automatic train control.

Questions submitted for discussion.

1. *a*) Where automatic train control or engine signalling is installed in home and distant (2-position) systems of signalling, is it necessary or desirable to retain the fixed visual distant signal ?

b) In automatic block systems, particularly those employing 3, 4 (or more) aspect signals, is it necessary or desirable to retain fixed visual track signals ? If so, at what points ?

2. Where signals are provided on the locomotive, *a*) is it preferable for them to be of acoustic or visual type or both ?

b) If of visual type, should they be supplemented by an acoustic device and vice versa ?

3. Where signals are provided on the locomotive, is it not also desirable to effect some control of the brakes ?

4. With locomotive signals, or automatic train control, should *a*) cancelling, *b*) forestalling, be permitted, and *c*) under what circumstances ?

5. Systems with movable track devices — *a*) are they practicable and satisfac-

tory in operation ? *b*) are there any restrictions as to their usage ?

6. The relative advantage and disadvantage of *a*) continuous and intermittent systems, *b*) non-contact and contact systems — are they so sufficiently pronounced as to exclude the use of any one system ?

7. In intermittent systems, assuming fixed track signals are retained, where should the track transmitter be placed :

a) before reaching the signal, and how far from it ?

b) in close proximity to the signal ?

c) beyond the signal, and how far ?

8. With locomotive signals :

a) is a distinctive « clear » signal necessary or desirable;

b) if so, should this be given by an entirely different function from that giving the warning signal ?

9. Excluding systems using train stop device — is an over-run section beyond the home signal necessary or desirable where systems are equipped with automatic train control applying to the distant signal ?

10. Can any standard of pre-existing signalling and/or traffic be defined as a necessary preliminary to the equipment of : *a*) intermittent, *b*) continuous, automatic train control systems ?

11. Where signalling systems are operated by intermittent telegraphic appliances — are not intermittent train control systems appropriate and satisfactory ?

12. Should locomotive signals and/or automatic train control be made responsive to speed restriction, as for curves, etc., which restrictions are not usually considered integral with the normal system of signalling ?

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

XIIth SESSION (CAIRO, 1933).

QUESTION XI :

Competition between or joint working of railways and airways, or railways and roadways. An investigation from the technical, commercial and contractual points of view.

REPORT No. 1

(America, Great Britain, Dominions and Colonies, China and Japan) (1),

by Edwin C. COX, C. B. E., M. V. O.,

Traffic Manager, Southern Railway of England.

At a time when the storm-clouds of deep industrial depression are hanging over the great Nations of the world, when the finances of the world powers are in a parlous condition, it is but natural that man, surveying the scene, should seek to find anything which may have contributed in some measure to the troubles by which he is beset. Man so engaged can hardly fail to examine the transport of persons and merchandise, for under modern conditions transport plays a great and, indeed, ever increasing part in the life of the world, and to question whether transport to-day is provided on a truly economical basis. Time was, not so very long ago, when transport by land could be summed up under one heading — *Railways* — for until the introduction and development of the internal combustion engine, there was no effective competition for internal transport.

In the early days of the motor vehicle few foresaw that an instrument destined to bring about a revolutionary change in transport by land had come into being, while still fewer thought that the evolution of such vehicles would proceed with such rapidity, that in the space of a generation, countries and, indeed, continents, would be covered by a network of road services for the conveyance of passengers and merchandise.

During the years from 1900 to 1914, when the motor vehicle was passing from the experimental stage through the period when it was looked upon as a luxury until the time when it had to be regarded as a necessity, the railway systems of the world were watching and measuring the new form of transport and were studying the situation from all its aspects. It is, indeed, highly probable that had world events followed a normal course, schemes for co-operation with this new form of transport would have been developed. Just at this stage, however, the great war shattered the peace of Europe, and for four years the strife and turmoil overshadowed all other questions. Moreover, the enorm-

(1) No reply, to the questionnaire sent out, was received from the Railways of China. As regards Japan, the answer of the Government Department of Railways was not received early enough to be included in the report.

ous demands upon the transport systems to fit and supply the large armies in the field caused a tremendous increase in the production of motor vehicles, not only in Europe but throughout the British Empire and in the United States. This increasing production, it should be noted, was not based on economic factors but was effected without regard to the cost involved as the need was paramount.

Simultaneously with the production of hundreds and thousands of motor vehicles, far more men were taught and became expert in the driving and maintenance of these vehicles.

Then in 1918 came peace, and it found the railways of Europe — and to a lesser extent in the British Empire overseas and in America — weakened by years of struggle, with plant and equipment in need of replacement and reconstruction, while the returning armies and their stores had to be brought home — a work not of weeks, but lasting through 1919 until 1920.

In every land enormous quantities of motor vehicles were subsequently disposed of as « surplus stores » at extremely low prices, while manufacturers, particularly in the United States, possessed plants capable of producing hundreds of vehicles a day, and so every need for the rapid development of road transport was available en masse — vehicles, drivers and mechanics.

The years from 1900 to 1914 had seen a gradual — one might almost say slow growth of motor transport — the decade 1920 to 1930 saw not an evolution of this means of transport, but rather an extension, so vast that vehicles were to be found operating in every conceivable place and street over the land as the spores are cast from an exploding mushroom.

The railway systems could not fail to recognise the menace to their very existence and to take stock of their position in this period of post-war chaos. The restrictions which lay upon them, the anomalies and difficulties with which they had to contend have been discussed at length at previous Sessions of this Congress and I do not propose to dwell upon the past but rather to deal in my report with the progress which has been made, with the position to-day and the outlook for the future.

Meanwhile, during these very years the introduction of air transport added a still further competitor for the conveyance of traffic over land and sea, although up to the present, owing to the restricted loads which can be conveyed by air, such competition hardly assumes the nature of a real menace to the railways of the world.

At the same time, other minds had been viewing the problem — the minds of legislators, financiers and the trading communities. Doubts began to arise as to whether this unchecked competition was indeed so « healthy »; whether the public who were called upon to expend huge sums of money in the reconstruction of roads, the building of new road arteries and the provision of police, parking places and other devices, did, in fact, stand to gain in the long run.

A Royal Commission was appointed to consider the position in Great Britain, and did, in fact, recommend the regulation and restriction in the public good, of this hitherto unchecked form of transport competition. Moreover, it recommended co-ordination with rail transport. Some of the recommendations of this Commission have already been passed into law.

In other countries, similarly situated, Governments have instituted Commissions to consider the problems, and have commenced to regulate the use of the roads by legislation.

The railways, for their part, have, during recent years, given much thought to the problem as it affects their interests, and I would especially refer to the work done by the members of this

Congress and, in particular, to the reports submitted and the discussions which took place at the Eleventh Session of the Congress.

Much useful and valuable information has also been compiled by the National Railway Union and by the Railway Research Service, and to all these Bodies am I indebted for portions of the information contained in my present report.

I now propose to examine conditions existing in the various Countries today, and to discuss the trend of events in those Countries, thus obtaining a picture of the world treatment of the problems, concerned in competition between, and co-ordination of, the various forms of transport over the land. There is, of course, no finality so far as transport is concerned, but perhaps the conclusions which I shall reach will serve as a starting off place for further studies of the intricate problems of transport.

Great Britain.

In Great Britain the railways have to face highly organised and powerful competition for the conveyance of passenger traffic, while there is the keenest competition for merchandise traffic from organised services and also from « free lance » vehicles.

Passenger traffic.

As regards passenger traffic over short distances, the railways are chiefly affected by Municipal and Company-owned tramway and omnibus services, while on intermediate and long distance routes competition arises with stage and express coach services. Beyond even this formidable competition lies the private motor car having an almost incalculable effect on railway traffics.

During the summer months over one million private motor cars are in use in this country and nearly 700 000 motor cycles, many of which are provided with side cars, while the technical development of road transport vehicles and the excellence of the highways of this country, encourage and enable road transport operators to compete for all classes of passenger traffic.

The annual expenditure on the highways of this Country amounts to no less than £60 000 000, and a considerable part of the final report of the recent Royal Commission on Transport is devoted to the various arguments which have been put forward as to the allocation of this cost between the general public and the road users. I do not propose to go further into this matter at the present juncture, but I shall have occasion to deal more fully with this very relevant factor in the conclusion of my report.

It is only necessary to say that the very intense road competition, subsidised as some would say by the ratepayer, has undoubtedly caused a serious loss to the railways, although it is not practicable to determine such losses with any degree of accuracy, owing to the many factors involved and the general effect of widespread trade depression.

Competition and co-ordination.

Prior to 1928 the four great railway systems did not possess powers enabling them to own, work and use road vehicles for the conveyance of passengers and merchandise, except that as regards merchandise, the companies have always provided and operated collection and delivery services. In 1928, however, various Acts promoted by the Railway Companies were passed and these enabled the companies to provide, own, work and use road vehicles in any district to which access was afforded by their systems for the conveyance of passengers, luggage, parcels and merchandise, but the companies were restricted in that they are not allowed to convey by road any pas-

senger who in any one journey is both taken up and set down in the Metropolitan Police area and the City of London; furthermore, it was provided that the companies should not, without the consent of the local authority of the area, enter into any agreement for the running of road vehicles in competition with any existing services of trams or omnibuses.

The four Group Railway Companies, armed with the powers thus given them by Parliament, have now obtained an interest in practically every large omnibus concern, as distinct from those municipally owned and worked, throughout the country except in the Metropolitan area itself, and it will be convenient to deal with that area separately. In no case is the financial interest secured by the railways more than 50 %. By reason of the measure of control secured steps are being taken to co-ordinate the road and rail services so that each can perform its proper function and can act as a feeder to the other. Already, as a result, facilities have been introduced for the inter-availability of return tickets by rail and omnibus, the issue of combined rail and road tickets covering journeys to and from outlying villages, the adjustment of rail services so as to facilitate the exchange of passengers and a combination of timetables. The co-ordination of road and rail services has been greatly facilitated by the Road Traffic Act of 1930. This Act brought under official control the operation of all public service vehicles, omnibuses and coaches. Under the Act, England, Scotland and Wales were divided into thirteen traffic areas, including the Metropolitan area, which corresponds to the Metropolitan Police area; this latter area I propose to deal with separately, as mentioned earlier. In the remaining twelve traffic areas the many licencing authorities existing hitherto have been displaced and their powers vested in Traffic Commissioners, three for each area. All operators of omnibus and motor coach services are required by the Act, before they commence operation, to secure a public vehicle license for each of their vehicles and road service licences for each service they desire to operate. The Commissioners, in granting the road service licences, are required to have regard to the suitability of the route, the extent to which the routes are already adequately served, the exent to which the proposed service is necessary in the public interest, the needs of the area as a whole in relation to traffic and the co-ordination of all forms of passenger traffic, *including transport by rail.*

The Commissioners may attach to any road service licence a condition that the fares to be charged shall not be unreasonable and that they shall be so fixed as to prevent wasteful competition with alternative forms of transport.

It is, of course, too early to form an appreciation of the effects of this Act but there is no doubt that it will do much to allow of the proper co-ordination of rail and road transport and will allow each form of transport to develop in its proper economic sphere to the benefit of each and the public in general.

The London area.

In the London area itself, that is the Metropolitan area mentioned above, exists one of the greatest joint road and rail passenger transport concerns, namely, the Underground Electric Railways Company of London Limited and its associated companies.

Mr. A. L. Barber, the Commercial Manager of that Company, has furnished me with a great deal of information in regard to passenger traffic in the area concerned, and I propose to quote extensively from the memorandum he has so kindly prepared.

The Underground Electric Railways

Company of London Limited was incorporated in the year 1902 and now controls, either directly or indirectly, the following passenger transport undertakings :

Railways.

1. The Metropolitan District Railway Company.
2. The London Electric Railway Company.
3. The City & South London Railway Company.
4. The Central London Railway Company.

Omnibuses.

5. The London General Omnibus Company.
6. The Tramways (M. E. T.) Omnibus Company, Ltd.
7. Overground, Limited.

Motor coaches.

8. Green Line Coaches, Limited.

Tramways.

9. The Metropolitan Electric Tramways, Limited.
10. The London United Tramways, Limited.
11. The South Metropolitan Electric Trams and Lighting Company, Limited.

The four Railway Companies operate over approximately 128 miles of route including joint lines and sections of the Southern, London Midland & Scottish, Great Western and Metropolitan systems, while the mileage of roads covered by services of the Omnibus Companies and other omnibus undertakings allied with them amounts to 1 186. The Green Line Coaches Limited operate 32 separate services of express coaches between the centre of London and points approximately 30 miles away. The three tramway systems consist of lines which have an aggregate route mileage of 113; in addition, they operate through services over the tramways of other authorities. The railway, omnibus and tramway companies in the group together carry 56 % of the total passenger traffic of greater London. The balance of such traffic is carried by the local services of the four group railway companies and the Metropolitan Railway Company, by the Tramways of the London County Council and other local Authorities in the area and by the road vehicles of independent proprietors.

The control of the eleven companies named by the Underground Electric Railways Company of London Limited provides a common policy and a common management.

Competition for passenger traffic in the greater London area exists between the underground group of companies and other operating authorities, the four main line railways, the Metropolitan Railway and other tramways and omnibuses and also between the companies forming the London Underground Group itself, but this latter competition is regulated by means of a common management of the companies.

The four Railway Companies now comprised in the Underground Group and the London General Omnibus Company obtained in 1915 a special Act of Parliament empowering them to pool all their revenue after meeting all revenue liabilities and to divide the balance in agreed proportions after meeting the deficiencies of any of the five companies. No clearance is made of through traffic between these five companies. In the case of the four railway companies and the three tramway companies maximum rates of fare are fixed by various Acts of Parliament relating to the undertakings. There are no statutory restrictions upon the fares which may be charged on the omnibuses and coach services. The ordinary fares actually charged on the railways, omni-

buses and tramways are on the basis of 1 penny per mile except that on the railways the fares for long distance journeys are lower than those charged on the tramways and omnibuses. Children up to fourteen years of age travel on the railways, omnibuses and tramways at one half the adult fares, while workmen's return tickets are issued on the railways and tramways on the basis of single fare for the double journey, a minimum of 3 pence in the case of the railways and 2 pence in the case of tramways, but there are no workmen's fares on the omnibuses.

Season tickets, although not required by statute, are issued by the railway companies at rates representing, a discount on the cost of single journeys for the period covered by season ticket. Season tickets available locally on the tramway and omnibuses services are not issued. Through single journey and season tickets available between certain stations on the railways and points on the tramway and/or omnibus routes outside the central area are issued via specified railway exchange stations. In the event of a breakdown on the railways in the group the holders of season tickets are permitted to travel without charge upon omnibuses between points comparable to the stations between which their railway season tickets are available.

Legislation.

Up to the year 1924 any person could operate a service of omnibuses in any part of England, Scotland and Wales, provided he could secure from the competent Licencing Authority approval of the vehicles he proposed to employ and a licence to operate the service proposed; the latter licence was given freely by most Licencing Authorities.

Inside the Metropolitan Police area, which corresponds generally to the area of greater London and the sphere of operations of the transport undertakings in the London Underground Group the Licencing Authority was the Commissioner of the Metropolis and he, in fact, would issue a licence to any operator whose vehicles conformed to his requirements if the roads being operated over were in his opinion safe. Outside the Metropolitan Police area the right to licence public service vehicles was exercised by various local authorities.

In 1924 the London Traffic Act came into operation; it introduced entirely new conditions in regard to the operation of omnibuses within the Metropolitan Police District. It became necessary under the Act for the omnibus proprietor to secure the official approval of the police to the route to be operated; he became under an obligation to maintain a regular service; he was bound to deposit with the police full particulars of the services to be provided by him and the fares to be charged; in addition the Minister of Transport was given power by the Act to prohibit or restrict the operation of public services through certain streets. Every omnibus proprietor had, therefore, to keep records of the services and to make full returns to the Minister of Transport. The Act provided for the enforcement of heavy penalties on omnibus proprietors infringing the provisions of the Act.

Between the years 1924 and 1930 came the great development of long distance express coach services into London; these services in fact, operated over many roads in the Metropolitan Police area which had been restricted or prohibited for ordinary omnibus operation.

In 1930 the Road Traffic Act governing the whole country passed into law and brought under official control the operation of all public service vehicles, omnibuses and coaches throughout England and Wales, as has been mentioned previously. In the Metropolitan Traffic area one Commissioner has been appointed and his principal duties are to deal with express services operated inside the Metropolitan Traffic area or

into that area from places outside and with tours and excursions run inside the Metropolitan Traffic area as within the Metropolitan area itself the ordinary short stage road services, i. e. omnibus services are outside his jurisdiction as they are still governed by the London Traffic Act of 1924.

It will be seen that the Underground Electric Railways Company of London Limited are in the position of managing a vast co-ordinated passenger transport system, in fact, more than half the total local passenger traffic of the London area, which is inhabited by many millions of people.

Prior to the general election which took place in this country in October 1931, a still further measure, the London Passenger Transport Bill, designed to eliminate uneconomical and wasteful competition between the Transport Authorities in the London area was under consideration by Parliament; this measure would establish a Board which would exercise control, not only over the Underground Electric Railways Company of London Limited and the whole of the Associated Companies, but also over the tramways of the London County Council and other local authorities and of independent owners of road passenger vehicles in the area concerned. A Joint Committee representative of the proposed Board and of the four great main line Railway Companies would be set up to discuss all matters of common interest and co-operation while a financial pool of the receipts derived from passengers whose journeys commence and finish within the area coming under the jurisdiction of the Board would be established. The pool would be divided amongst the parties (the Board and the four Main Line Companies) in proportion to their ascertained receipts from such traffic during a standard year to be determined.

To ensure that the interests of the public are adequately protected local authorities within the area covered by the jurisdiction of the Board would be empowered to make representations to the Minister of Transport and the Railway Rates Tribunal in respect of travel facilities or fares; these representations might relate to the services of the Main Line Companies as well as those of the Board and the Minister of Transport would be empowered to require the maintenance of existing or the institution of new services subject to certain limitations as to new capital expenditure; similarly, the Railway Rates Tribunal would be given powers to modify charges in response to representations made to them.

At the moment this measure has not been proceeded with owing to the change of Government, but it seems highly probable that sooner or later some such measure will be introduced and passed into law thus establishing a co-ordinated passenger transport system on á vast scale.

Steps have been taken by the railways to *meet* road competition apart from the steps which have been taken to *co-ordinate* road and rail transportation and which have been outlined in the preceding portion of my report.

The railway companies of England have taken such measures as they can to attract passenger traffic by improving the services available and by offering such facilities at as low a rate as is economically possible. In passing I would mention that my Company, the Southern Railway of England, have actually electrified the whole of their suburban area affecting all the lines radiating from the terminal stations in London to a distance of approximately 20 to 30 miles, covering the southern part of London from the Thames at Gravesend in the east round in a half circle to Windsor west of London. This represents the greatest suburban electrification scheme in existence in the world, covering a route mileage of 257,

handling over 200 million passengers a year and producing a revenue of nearly £5 000 000.

At the moment my Company are electrifying the main line running from London to Brighton, Hove and Worthing on the South Coast. These towns are being developed, apart from their natural attractions as holiday resorts, as dormitories for those who work daily in London. There is already a very large rail traffic between London and these towns on the South Coast and owing to the short distances involved competition from express motor coaches and private cars is intense.

The present steam train mileage of nearly 2 000 000 per annum will in fact be replaced by an electric train mileage of nearly 5 000 000 and there is every reason to believe that the traffic conveyed by railway will be greatly increased.

I would also draw attention to another technical accomplishment — a road-rail motor coach. This vehicle, in appearance similar to an ordinary motor coach, is capable of proceeding along the railway at a high rate of speed under its own power and, at the termination of the railway can be run off on to the highway on which it runs supported by normal pneumatic tyres. The steel tyres necessary for running on the railway and the pneumatic tyres for running on the road are both carried on the same wheels, and the change into position and locking are accomplished in a few minutes with a minimum of special appliances. Technically it would be possible with this vehicle to operate a service over a branch line of railway and extending into the country beyond the railhead. A new field of exploration is opened up, although it may be doubted whether any such development would be economically sound in this country.

Goods traffic.

In this country the conveyance of merchandise by road vehicles has not developed on the same lines as the conveyance of passenger traffic. In the latter case, as I have described, very keen competition does exist, but since the various railway Acts of 1928 a large measure of co-ordination with the railways has been secured until the position has arisen whereby such co-ordination has been extended to cover practically all the operators of road omnibuses throughout the country. Road competition for the conveyance of merchandise, while it is just as keen and has undoubtedly caused severe losses to the railways, is at the same time less organised, and apart from those industrial firms operating their own vehicles, of which there are, of course, a great number, is comprised of road carriers varying from the free lance with one vehicle to the large road haulage contractors. The actual number of commercial road vehicles in use in Great Britain is shown by the following figures :

Licences current in respect of ordinary goods commercial vehicles at the 30 September for the years 1926 to 1930.

	1930	1929	1928	1927	1926
Up to 3 tons	285 660	264 462	241 862	222 698	197 378
Over 3 tons	55 274	58 847	58 309	58 340	58 735
6 and 8 wheelers	1 986	1 215	858	504	407
Electric	1 752	1 683	1 477	1 363	603
	344 672	326 207	302 506	282 905	257 123

It will be seen that the number of ordinary heavy lorries in use has actually declined slightly during the past year or so but that there is an increase

in the number of 6 and 8-wheeled vehicles. The vehicles of up to 3 t. capacity are chiefly tradesmen's delivery vehicles and do not, therefore, represent competition with the railway for heavy and long distance haulage. The total number of commercial road vehicles seems small in comparison with the extraordinary figure provided by the United States where it is estimated that there are over 3 400 000 vehicles in use, but the conditions are entirely different in Great Britain, the distances between the industrial and commercial centres, the great cities and the sea ports, are comparatively small and the position cannot be compared with that appertaining to a great continent. The industrial areas of the Midlands are only from 120 to 150 miles from London and its docks, while the cotton mills and engineering shops of Lancashire and the mills and works of Yorkshire are even nearer to ports on the Irish Sea and North Sea. The size of the country itself and the concentration of population and of industrial areas all tend to facilitate and favour the transport of merchandise by road.

The excellence of the roads and the progress of technical development enable road transport operators to compete for all classes of traffic including even the lowest in the railway classification. Tests which have been made in certain areas enable the following estimated figures to be given showing the character of the total roadborne tonnage described in terms of the British railway classification :

Classes 1 to 2.	Classes 3 to 6.	Classes 7 to 10.
7 %	22 %	24 %
Classes 11 to 16.	**Classes 17 to 18.**	**Classes 19 to 21.**
35 %	10 %	2 %

It has been seen that the Road Traffic Act of 1930 has commenced to regulate and co-ordinate the transport of passengers by road but the same cannot be said of the conveyance of merchandise by road. The recent Royal Commission did, indeed, recommend a system of licencing governing the operations of road transport operators but this recommendation has not so far been followed by legislation. The Act of 1930 did, however, contain provisions affecting the conveyance of merchandise by road motors, provided a speed restriction dependent upon the type of vehicle and placed restrictions on the driving of vehicles by young persons; nor does it permit of the driving of vehicles for any continuous period of more than 5 1/2 hours or for continuous periods amounting in the aggregate to more than eleven hours in any period of 24 hours commencing two hours after midnight. The driver must have at least ten consecutive hours of rest in any period of 24 hours, furthermore, a certificate of insurance or a security is necessary to cover third party personal risks. Other sections of this Act also lay down various maximum weights and dimensions for vehicles and, all motor vehicles are subject to taxation dependent upon the carrying capacity of the vehicle, varying from £10 to £60 per annum with an additional duty if used for drawing a trailer; in addition a duty of 8 pence per gallon is levied on motor spirit.

Resulting from the various Railway Acts of 1928 the railways of Great Britain are now empowered to operate road services for the conveyance of merchandise apart from the collection and delivery services which they have always operated, but certain restrictions are placed upon them :

1. The rates charged must be reasonable.

2. Services may only be operated in the area to which access is afforded by the system of the Company.

3. The Railway Company shall not restrict the use of any of their bridges

from the use of road hauliers which they themselves use for like traffic.

4. Regular road services, i. e. services running regularly on public roads, must be reported to the Minister of Transport and must not be withdrawn without his permission. (The bulk of the traffic carried throughout by road, however, comes under the heading of *contract* services for particular traders to which this condition does not apply).

5. Separate accounts have to be kept in respect of throughout transport in specified form.

Road hauliers other than the Railway Companies are not governed by the above conditions. Owing to the nature of road transport for the conveyance of merchandise the railways have not, generally speaking, made any attempt to secure an interest in merchandise road transport organisations as they have done in the case of passenger concerns but rather have they tried to combat road transport. The loss of revenue due to the diversion of merchandise traffic cannot be expressed accurately but it has probably been due to the following chief causes :

1. Lower rates by road.

2. Door to door service with less handling and packing and delivery to site as in the case of road material, drain pipes, bricks and such like commodities.

3. Railway Company's conditions of carriage as to risk respecting certain traffics.

4. Speed of transit, e. g. same day delivery.

5. Establishment of domestic transport by traders coupled with complete elasticity in the application of conditions under these heads.

The principal means which have been adopted by the Railway Companies to meet the situation are :

a) Reduction of rates;

b) Provision of containers;

c) Affording complete door to door services by means of cartage at one or both terminals;

d) Provision of cartage services in country districts;

e) Provision of storage facilities;

f) Express freight trains and expedition of transit by the part use of motor transport.

The first of these means, reduction of rates, is one which can and is used to secure and retain to the railway traffics which would otherwise pass by road, but even in this instance the railways are in a restricted position as compared with road transport operators. Various Railway Traffic Acts, principally those passed in 1855, 1888 and 1921 impose regulations and conditions upon railway companies in connection with railway rates and charges. The principal features under this heading are :

1. Obligation to publish rates and charges.

2. Maximum powers of charging.

3. Obligation to avoid undue preference as between one trader and another.

4. Obligation to obtain sanction of Railway Rates Tribunal for operation of all rates below a prescribed level or for any variation in classification of goods.

These features render railway rates inelastic, whereas there are no similar requirements imposed upon outside road hauliers who are free agents and can quote rates how and when they will; they are also in the position to accept and decline traffic at their discretion.

Mention may also be made of another more or less experimental method of charging which is now being tried on British Railways, known as the «unit» or flat rate method of charging.

With regard to the first-named, arrangements have been completed with certain firms for the charging of their

traffic at an average rate per ton, or at an average rate per unit, i. e. package or consignment, and the average rates in question are based on the actual charges paid during determined periods with, as a rule, a small deduction which may be said to represent a saving in clerical cost to the Firm and the Railway Companies by the adoption of the arrangement. It is made a condition of these agreements either that the Firm concerned shall hand the whole of their traffic to the railway or shall guarantee a certain minimum tonnage. This arrangement is, of course, not dissimilar to that adopted in connection with traffic which has for many years been carried by « contract »; for example, in this country the whole of the mails carried by railway form the subject of a contract between the respective railway companies and the Postmaster General. The sum payable has been determined by past experience and is subject to review from time to time, in the event of an alteration in the conditions.

Experiments have also been made with the provision of « per truck » rates by which rates per ton for 2, 4 or 6-ton lots, irrespective of the classification of the commodities, are quoted. It is not possible at this stage to say whether or not such a policy would have beneficial results although it is one which is largely adopted by road hauliers. It will be noted that such a plan cuts across the railway rate structure as it exists generally to-day in all countries.

With regard to the use of containers the many advantages conferred by these appliances will be well known to all; their use is being rapidly extended and there are now about 6 000 in service on the railways of Great Britain. The charge made for container service consists of the ordinary rate for the merchandise conveyed in the containers plus a small percentage, varying with the commodity, for the use of the appliance.

It is highly probable that still further uses for containers will be found and probably containers provided with road wheels enabling them to be hauled by tractors will be developed as has been done in America.

A further example of co-ordinated service is to be found in the carriage of milk. Owing to the great size of London there is a very large milk traffic from distant country areas to supply the needs of the Metropolis.

Until a few years ago the whole of the milk was conveyed in churns holding from 10 to 17 gallons and loaded in the vans of ordinary trains or special milk services. Obviously this is not an economic means of transport; the amount of labour required for handling is very considerable, while the deadweight of the churns is great.

Special tank wagons, designed solely for the conveyance of milk, were developed and placed in service, but these can only be used when the dairy premises in the country and also the depot in London are adjacent to the railway. The tanks are of 3 000 gallons capacity and are not, of course, suitable for the conveyance of small quantities of milk. A further co-ordinating measure was, therefore, necessary to take the form of a vehicle which could collect milk *by road* in the country districts, be conveyed to London by express train milk service and then, if necessary, proceed to the dairy premises in that city by road.

Recently such a service of road-rail milk tanks has been inaugurated on the Southern Railway between the West of England and London. The road-rail vehicle consists of a 2 000-gallon tank mounted on a 6-wheeled trailer chassis provided with pneumatic tyres and weighing about 16 tons. These vehicles are the property of the Co-operative Wholesale Society, Ltd. and can be haul-

Fig. 1. — A number of specially constructed milk tank wagons; each tank has a capacity of 3 000 Imp. gallons.

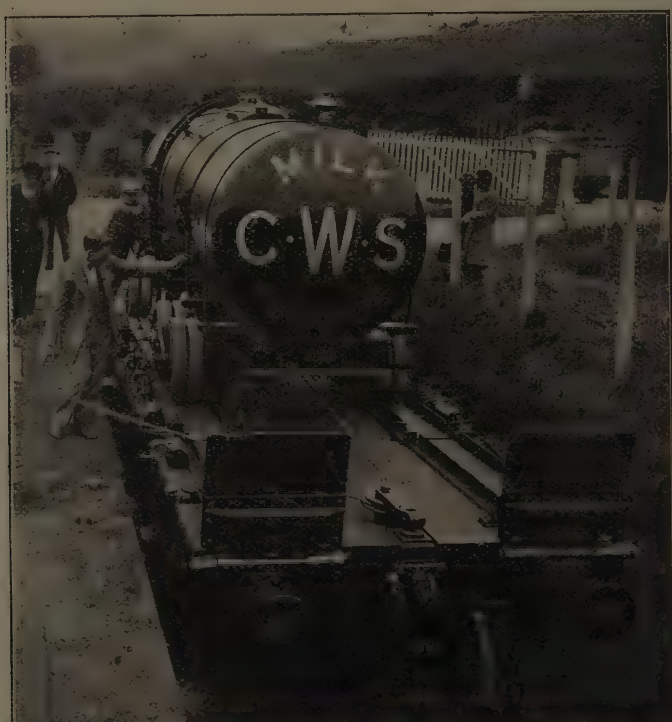


Fig. 2. — Road rail milk tank being loaded on to specially constructed rail vehicle.

Fig. 3. — Road rail milk tank in position on railway vehicle.

Fig 4. — Milk being syphoned from rail milk tank after arrival in London.

ed by an ordinary motor tractor. On arrival at the railway station they are easily run on (endways) to a specially constructed four-wheeled vehicle provided by the railway and they can be hauled off the vehicle with equal facility.

The provision of road motors for cartage purposes has enabled the railways to extend collection and delivery areas, thus providing a more effective door-to-door service. Particularly has this been the case in Country districts, where by the provision of « railheads » at the larger centres and of an adequate number of motor vehicles it is possible to provide an efficient door-to-door service over a wide territory. This policy has also been assisted by the provision of storage accomodation for traders at stations, and particularly at railheads. In some cases, existing buildings have been utilised for the purpose, while in others, by arrangement with the traders, special buildings have been provided, suitable for the purpose in view.

The provision of storage facilities benefits traders, as distributors of merchandise, foodstuffs and agricultural requirements can establish depots at the railhead, where a stock can be maintained at a minimum cost, and readily available for immediate delivery to meet the needs of local traders and consumers. The distributor also secures a further advantage by the bulking of his traffic, while the railway, of course, secures, or retains, the traffic.

With regard to the speeding up of the transport of merchandise, much attention has been given to the improvement of freight train services generally, and a similar result has been secured by distributing from comparatively large railheads by road vehicles instead of working the traffic to near-by local goods stations.

With regard to goods traffic, therefore, it can be said that while on account of the nature of the competition co-ordination with rail transport is not taking place at the moment on the same lines as the co-ordination secured in regard to the conveyance of passenger traffic, the railways of Great Britain have, and are nevertheless, taking steps to meet the competition by all the means in their power, including the use of road vehicles for their own purposes.

Airways.

In Great Britain the density of the population and the short distances separating the industrial centres from the commercial centres, the very factors which have proved so favourable to transport by road, equally reduce the primary advantage of aircraft... *speed*. The facility and speed with which passengers can be transported from city to city by normal surface travel are so good, and the distances so short that the time which would be saved by airway is not great, particularly when the time required to travel from the heart of a city to an aerodrome is considered.

In this country, therefore, the only airway competition is that resulting from the provision of airways to the Continent and operated by Imperial Airways, Ltd. and other companies.

As regards Imperial Airways (in which the Southern Railway have a financial interest) a subsidy of over £300 000 per annum is at present paid by the Government of Great Britain, and this has enabled the airway to earn small profits in recent years — amounting to £60 000 in 1930. It is of interest to note that one of the conditions attaching to the subsidy is that the fleet of aircraft shall be written off every four years — hence the charge for obsolescence is considerable and in 1929-1930 amounted to £ 85 000.

An additional subsidy, it may be mentioned, is payable in respect of the African route now being developed.

In the case of journeys between Lon-

don and such cities as Paris, Brussels, Berlin and Cologne, there is a considerable reduction in journey time, and the provision of these facilities has undoubtedly caused some diversion from the rail and boat service of first class passengers, but it is also probable that a certain amount of new traffic has been created.

Again, on account of the speed of transit, a certain amount of oversea mails traffic, bullion and luxury articles have been diverted to the Airway.

Prior to 1929, the railways of Great Britain did not possess powers to operate airways, but in that year various Railway Acts provided such powers although, as yet, these have not been exercised.

Agreements have, however, been entered into with Imperial Airways Ltd. (and Associated Companies parties to the International Air Traffic Convention) for combined rail and air rates for the conveyance of freight traffic, the railway companies acting as agents for Imperial Airways, and in such cases the rail proportion of the charge is the appropriate rate for the rail portion of the journey.

The services thus provided extend to the airway stations of the Imperial Airways in Europe, Egypt, Iraq, Persia, India and Central Africa and, enables a great saving of time to be secured in the transit of urgent parcels traffic. The traffic is conveyed from the stations of origin to London by rail and thence to the London terminal air port at Croydon by the motor service of the Imperial Airways. A cash on delivery system by which the value of goods up to a maximum of £40 is collected on delivery has also been provided, and this should be of considerable service to traders having dealings with customers in those countries.

Arrangements are also in operation whereby passengers who abandon their journey by air, or who are landed in emergency from aircraft, may complete their journey by railway. The pilot issues to the passenger a voucher which is handed to the booking clerk at the station, in return for which a first class rail ticket is issued free of cost to the passenger. The railway company subsequently claims the fare from Imperial Airways. Arrangements are also being made for the provision of tariffs for the through registration of the baggage of passengers travelling by air.

It will be appreciated, therefore, that the railways of this Country have taken early steps to secure co-ordination with airways and, needless to say, further co-ordination is probable in time to come.

Ireland.

In Ireland, as in Great Britain, keen road motor competition exists for the conveyance of both passengers and merchandise. As is the case elsewhere, the passenger transport side is generally well organised and operated by companies, but the conveyance of goods is mainly undertaken by « free lances » although the resulting competition is intense.

In Northern Ireland and in the Irish Free State the railways have been empowered to operate road services, in the first case by the « Railways (Road Vehicles) » Act (1927), and in the second by the Railways « Road Motor Services » Act (1927), and the powers so conferred are widely exercised. In Northern Ireland the operation of road motor passenger services is controlled by the Minister for Home Affairs and services cannot be operated without a route licence, the issue of which is dependent on the need for the service in question; fares are also controlled by a tribunal without whose authority no alteration can be made.

In the Irish Free State an Act conferring similar powers on the Minister for Industry and Commerce is now un-

der consideration. The motor vehicles « Traffic and Regulation » Act, Northern Ireland, also provides conditions under which licences are issued to persons driving public service vehicles and restricts the speed of such vehicles to 23 miles per hour, while legislation now contemplated in the Irish Free State contains similar provisions.

Both in Northern Ireland and the Free State regulations of a similar nature are in operation in regard to the dimension of vehicles, safety precautions, brakes, clearances, etc.

The taxation of public service vehicles throughout Ireland is on a passenger seat basis; in Northern Ireland a tax is levied of £2-10-0 per seat per annum and the Free State £5 per seat per annum, while with regard to commercial vehicles over the operations of which there is no control, taxes in Northern Ireland vary from £6 per annum in the case of 12-cwt. vehicles to £100 per annum in respect of vehicles exceeding 5 tons, while in the Free State corresponding taxes vary from £10 to £105. In each case an additional tax is raised in respect of a vehicle drawing a trailer, the actual figure being £10 per annum in Northern Ireland and £12 in the Free State.

United States.

In the United States the road transport competition for the conveyance of passengers and merchandise is highly developed and well organised, covering all classes of traffic including such heavy traffics as coal, cement and steel.

No actual estimate of the loss of railroad revenue due to this competition has, however, been made.

The Pennsylvania Railroad report that in 1923 their revenue from passenger traffic amounted to $164 004 518, but in 1930 this had fallen to $115 439 359, a decrease of $48 565 159. Much of this fall in traffic is due to road competition and particularly to the use of the private car.

During the same period of time, the number of motor trucks registered in the United States has increased from 1 612 569 to 3 480 939.

It has, in the past, been the practice of the railroads to combat road transport competition, but recently a number of the railroad companies have attempted to co-ordinate rail and road services through the medium of subsidiary companies, as it is recognised that railroads *cannot hold* to the railroads a monopoly of transportation and that co-ordination should be such as to enable each agency to perform in the field to which it is best adapted and render maximum service at minimum cost.

In the case of the subsidiary road services operated as mentioned above, services have been provided to operate as feeders to the rail and, in some instances have given a parallel facility.

The subsidiary of the Pennsylvania Railroad, for example, operates road passenger services over routes parallel to approximately 5 568 miles of railroad and during 1930 operated on these routes 17 184 000 'bus miles and carried 6 150 000 passengers. Furthermore, on certain sections subsidiary road services have been substituted for unprofitable train services.

The railroad subsidiary companies do not generally operate road services for the conveyance of merchandise, although the West Virginia Transportation Company, a subsidiary of the Baltimore and Ohio Railroad Company, do operate a few services, as does the subsidiary of the Pennsylvania Railroad in replacement of station to station local peddler freight train service. Apart from the control which is exercised over such subsidiary undertakings, the railroads do not possess or exercise any measure of control over road transport operators.

The technical development of road passenger vehicles is very advanced in

this country, but for long journeys the train affords superior advantages both as regards speed and comfort, particularly when the long distances involved are considered.

There are no Federal laws governing highway operations, but each State has its laws covering « intrastate » operations and governing the size, weight, speed and taxation of vehicles, while in most cases the general powers of State Commissions convey the authority to fix, alter and regulate schedules, rates and tariffs with respect to common carriers engaged in « intrastate » transportation... there being no such control by any government agency of the « interstate » operator.

The Interstate Commerce Commission through Federal legislation has entire jurisdiction over all fares, rates and charges, both passenger and freight, in transportation by railroad, but there are no laws enacted by the United States Government controlling rates, fares and charges made by highway transportation companies, and it is stated by the railroads that this prevents the railroad companies from adequately meeting highway competition.

It is suggested, according to a report issued by the Railway Research Service, that *Federal* regulation should, however, regulate the operation of omnibus companies engaged in interstate traffic by requiring such companies to :

a) Publish and adhere to tariffs;

b) Maintain just, reasonable and non-discriminating rates, without undue preference or prejudice;

c) Keep prescribed accounts;

d) Make prescribed reports;

e) Comply with rules as to condition of services and safety of operation;

f) Adhere to schedules without permission to abandon or commence new services without certificates of public necessity and convenience;

g) Provide guarantees of adequate financial responsibility.

It is recommended that regulatory bodies should have the power :

1. To suspend certificates.

2. To require adequate service.

3. To permit transfer of certificate from one bus line to another.

4. To permit consolidation of bus lines without discrimination as to ownership.

In certain instances combined road and rail passenger fares are in operation with the railroads subsidiary companies, the basis of the rail proportion being the basic fare of 3.6 cents per mile. In such cases the operating company assumes full responsibility for its portion of the journey. In some instances the service provided by the subsidiary road companies have enabled the railroad to reduce or cease to operate rail services while the whole position is being made the subject of close study.

The railroads of the United States have, needless to say, given much study to the effect of road competition and the steps necessary to meet the situation.

As far back as 1923, the Pennsylvania Railroad began the co-ordination of truck and rail transportation through the substitution of motor trucks for local peddler trains in station to station service wherever it developed that economies could be effected and the movement of traffic expedited. These trucks are operated by trucking companies under practically uniform contracts, and the service has been extended until it now covers 49 routes and 709 stations, and accomplished an annual saving of $1 335 000.

Another innovation has been the adoption of containers on similar lines to the present practice in Great Britain, although it would appear that much greater use is now being made in the eastern part of the United States, while further, the Pennsylvania Railroad state

that they have adopted a container system to secure greater efficiency in the carriage of less than car-load traffic.

Investigation shewed that approximately 30 % of the box cars on the Pennsylvania Railroad were carrying loads of less than carload freight, in fact averaging about 6 tons. This meant that box car equipment was being utilised only to 12 % of capacity. To secure heavier loads and to expedite the movement of less than carload freight and avoid the physical handling of it at transfer stations, the container has been placed in service for the transportation of less than carload freight at regular rates from station to station. In this plan freight is loaded directly into and from the containers while loaded on flat cars. The use of containers in this service, in lieu of box cars, is for railroad convenience for the purpose of economy and expedition of movement. Substantial reductions in operating expense have been accomplished through the elimination of the necessity for physically handling freight at transfer stations and there are approximately 4 000 containers utilised in this service to-day serving approximately 100 of the larger centres of distribution on the Pennsylvania Railroad.

Through a subsidiary the Pennsylvania Railroad has also acquired an interest in trucking companies in various cities. This action was taken, it is stated, not for the purpose of restricting the activities of the trucking companies, but for the purpose of co-operating with them to insure the public being supplied with the required trucking equipment for the transportation of the containers between the store door and the rail head. This trucking service is carried on independently of the railroad operations. The truckers with whom these arrangements have been effected have been selected because they are able to provide equipment to handle containers.

The American Railways have not provided in the past a collection and delivery service which could be compared with that afforded by the railways of Great Britain and, in a sense, this had rendered more difficult the provision of door to door services to meet the competition of road transport operators. On the other hand a large volume of smaller traffic in the United States is handled by Express Companies (notably the American Railway Express Company) — a practice which has hardly any counterpart in my country.

The container is very suitable indeed to meet the needs of such forwarding agents and a large proportion of the traffic conveyed in containers originates from this source.

The Pennsylvania Railroad is not engaged directly or indirectly in the operation of motor trucks over the highway in line-haul service except as has been described before where the truck is used in substitution in certain areas in lieu of local peddler freight trains. The investigations which this company have carried out show that on the basis of sound economy and co-ordination of highway and rail service, it is obvious that the motors should perform the terminal deliveries and the rails the line haul, and acting together these agencies should be able to give the public cheaper transportation, with improved methods, without lessening the return to either.

A further step which has been taken by the Pennsylvania Railroad is the carriage of road truck bodies for the trucking companies, as investigation showed that the preponderance of truck competition is within a 250-mile zone from any given large city, reaching its peak in the first 100 miles and, therefore, a co-ordinated transport arrangement was created whereby the railroad may transport within the 250-mile area the truck bodies for the trucker at a charge below the trucker's costs, the plan contemplating that the rail carrier would be relieved of a portion of its terminal work and the trucker of the line haul.

Under the plan the trucker delivers his truck body to the railroad, where it is lifted by crane and placed on a freight car and transported to destination, where it is again placed on a truck chassis for terminal delivery by the trucker. No figures as to the result of this plan are given, and it will also be apparent that the geographical conditions in the United States, which permit such a plan to be adopted, are somewhat different from those in, e. g. European countries.

Airways.

The United States is a land of vast distances and of great cities widely spaced, providing a scene entirely suitable for the development of airways which, under these conditions, can reap full benefit from their inherent advantage... *speed.* Furthermore, in this great country the technical evolution of aircraft and the financial and industrial means exist in plenty to provide highly developed airways.

It is hardly a matter for surprise, therefore, to find a network of airways connecting New York, on the Atlantic, with the cities on the Great Lakes, the Pacific Ocean and the Gulf of Mexico. It has been estimated, for example, that the transcontinental airway connecting New York and San Francisco serves centres with a total population of 40 000 000 — a Nation in itself.

During 1930, the last complete year for which figures are available at the time of writing, 417 000 passengers were carried on scheduled air services, while the mileage flown amounted to nearly 40 millions. The mails carried amounted to 8 324 255 pounds and the express (parcels) to 2 869 255. These figures demonstrate vividly the position already attained by aircraft under ideal conditions, which, I may say, differ entirely from those to be found in a small, compact and densely populated country such as Great Britain.

A number of examples of the relative advantages of airway travel have been provided by the United States railroads and I give some of these below :

Railroad.	*Journey.*	*Distance.* By rail. Miles.	*Distance.* By air. Miles.	*Times.* By rail. H. M.	*Times.* By air. H. M.
Delaware and Hudson	New York to Montreal	384	Approx. the same	10 0	4 0
New York Central Lines	Cleveland to Detroit	184	90	4 15	55
	Cleveland to Chicago	340	318	6 45	2 16

The Pennsylvania Railroad gave full details showing the comparison between the railroad and airway travel over a comparatively long distance, i. e. from New York to St. Louis, and these figures are given below in full :

Comparison of air and rail service.
Example. — New York to St. Louis passenger service.

Cost.

RAIL.	— Regular one-way fare	$ 38.06	
	Extra fare for « 23-hour » service which is fastest rail service (actual running time 22 h. 50 m.). Extra fare based on charge of $ 1.20 per hour for each hour under normal fare time of 28 hours	6.00	
	Lower berth in sleeping car	10.88	
	Meals en route (minimum of 2) estimated	2.50	$ 57.44

AIR. —	Transportation from New York to airport	$ 0.75	
	One-way fare	65.00	
	Transportation from airport to St. Louis	1.00	$ 66.75
	(Meals aloft included in transportation charges.)		

Time.

RAIL. —	Elapsed time for fastest rail service	22 h. 50 m.
	Various services from 22 h. 50 m. to 28 hours.	
AIR. —	New York City to airport, including necessary time for connection, etc.	1 h.
	Flying time, airport to airport	9 h. 59 m.
	From airport to St. Louis	50 m.
		11 h. 49 m.

Mileage.

RAIL. —			1052 miles.
AIR. —	New York to airport to airport	14 miles.	
	Air mileage — airport to airport	919 miles.	
	Airport to St. Louis	16 miles.	949 miles.

Note. — Air Lines generally are giving 5 % to 10 % reduction for round trips.

It will be seen from these figures that, comparatively speaking, the airway costs are little higher than the corresponding railroad costs to the passenger and that the actual transportation time is halved by airway.

The Baltimore & Ohio Railroad stated the operations between air and railroad services for 25 typical trips between important business centres show the following averages :

Time is 3 to 4 times longer via rail service;

Distances by airway are 25 % shorter and fares 35 % more than by railroad.

The New York Central Lines state that the business diverted has been comparatively small, but the Baltimore and Ohio Railroad report that to meet this form of competition trains have been speeded up, additional comforts added in the way of air conditioned trains placed in service between New York and Washington, and the precooling of sleeping cars on night runs from all large commercial centres. The Pennsylvania Railroad has also taken steps to quicken up and improve its services.

The railroads if they desired to operate airways, which they have not done so far, would have to apply for a permit to the United States Department of Commerce, which they have the right to do at any time. The railroads of the United States have, however, entered into co-ordinating agreements with the airways on a large scale. These arrangements enable through rail-air services to be provided, connections being made at the large centres, while the provision of through tickets assists the traveller. In such cases the railroad receives as its proportion the full fare for the distance covered by rail. The airways have undoubtedly diverted traffic from rail and, in some instances even night services are operated. Much public money has been expended by government and municipal authorities in the provision of air ports, airways, lighted for night flying, and auxiliary landing fields.

Canada.

Canada, while geographically having much in common with the United States, is very differently situated as regards

density of population, provision of highways and hence road competition. The total population is only about 10 millions as compared with the population of 122 millions of the United States, and consequently the average density is extremely low.

The two great railway systems of Canada, the Canadian National Railways and the Canadian Pacific Railway, while having to face keen road competition around the larger cities, do not experience competition comparable to that affecting the eastern railroads of the United States. Nevertheless, road competition to an increasing extent is causing serious loss to the railway systems.

Omnibus competition exists around the cities, but only a proportion of the passengers conveyed by these means can be regarded as diverted from the railway, as much of the traffic is « new » and arises from the opening up of districts by the construction of highways and provision of road transport.

Competition for the conveyance of merchandise arises from trucking companies and from individual owners throughout the Dominion, but the long distances involved limit to a certain extent the uses of road vehicles.

It is the policy of the railways to combat road competition, but, at the same time, co-operation is sought where the two Agencies can act in a complementary manner.

With regard to legislation, each Province has established some form of control, especially in regard to the operation of passenger services.

A report prepared by the Railway Research Service states that in Ontario the regulations prescribe the number of hours which may be worked by a driver and require insurance to be effected varying from $5 000 to $20 000 for vehicles seating from 21 to 30 passengers, and $1 000 for property damage.

Suitable limits are also placed on the length, weight and speed of vehicles, while registration fees depend on the weight and type of tyre, varying, for example, from $24 for a 2 1/2-ton vehicle mounted on pneumatic tyres to $154 for a 10 1/2-ton omnibus on solid tyres. The regulations of the various provinces, it may be stated, differ considerably.

The situation with regard to the regulation of services and issue of permits consistent with the needs for such a service is of interest, and I cannot do better than quote the words of the Railway Research Service Bulletin No. 1 dated January 1932 :

> The point is stressed that regulation of road passenger services which necessitates a permit before operation can be commenced is of considerable assistance to the road operator in that it protects him from destructive competition, and it is clear that regulatory bodies in Canada have been very careful to limit permits to one operator over any one route; but only New Brunswick up to the end of 1929 had definitely made provision in its legislation for due consideration to be given to existing services before the granting of a bus operating certificate. Owing to adherence to the policy of one operator to one route, the certificates granted have attained a good-will value which can be expressed in terms of currency, and in one case have been sold at a rate of $4 000 per mile. In most cases such certificates are renewable each year, and up to 1930 no responsible operators had been refused renewals.

It will be seen that the policy which has been adopted in New Brunswick bears some resemblance to that now in operation in Great Britain, inasmuch as definite regard is had to the elimination of wasteful uneconomic competition.

Airways.

As in the case of rail and road, the enormous distances to be traversed in Canada make a situation geographically similar to that of the United States, but,

of course, the comparison cannot be carried far beyond this point, as the population and hence the density of traffic, is entirely different.

A considerable airway service has, however, been built up in Canada, particularly in the Western Provinces, and the Canadian National Railways give the following comparison of the journey times between Winnipeg, Regina, Calgary and Edmonton, and these, I think, are of some interest as showing the saving which is effected on journeys of considerable length :

Rail time.		*Points.*	*Railroad. miles.*	*Air time.*	
0	0	Winnipeg	0	0	0
12 h.	30 m.	Regina	356	3 h.	20 m.
15 —	00 —	Moose Jaw	399	4 —	10 —
35 —	45 —	Calgary	903	9 —	40 —
25 —	10 —	Edmonton	802	11 —	45 —

The diversion of traffic from rail has, however, been comparatively small, and it has not been possible to take any special steps to meet this competition, except by co-operation, and jointly with the Canadian Pacific Railway, the National Railways have made co-operative agreements with Canadian Airways. The Presidents of each Railway are on the Airways Board, and various arrangements have been entered into with a view to mutual benefit, but it is stated that on account of the prevailing economic depression operations have so far been very limited.

Australia.

The losses suffered by the state-owned railway systems of Australia have been so serious since the war that in 1928 the Commonwealth Government set up a Committee known as the Commonwealth Transport Committee who were required to see in what manner co-ordination of all forms of transport in Australia might be effected. This Committee investigated the matter and made full report on the subject with great rapidity and in the opening portion of that report the following information was given showing the financial position of the railways and also giving an idea of the development of motor transport.

Railways.	*Mileage.*	*Capital cost.*
State Railways. .	23 413	£300 000 000
Commonwealth Railways . . .	1 733	£ 12 000 000

Losses on State Railways.

1925 to 1926	£2 700 000
1926 to 1927	£3 500 000
1927 to 1928	£4 700 000

Furthermore, it is stated that even these losses do not cover adequate provision for depreciation.

The Australian railway system has, of course, followed a policy of extension and in many cases such extensions have been made into more or less virgin country with a view to its ultimate development, and it is stated that during the years 1904 to 1914 the capital cost of the railways was increased by 37 % but that the goods traffic conveyed during the same period of time increased by 91 %. From 1914 to 1928, however, the capital cost was increased by 73 % and goods traffic by only 21 %, so that the ratio of capital cost to traffic conveyed altered very considerably.

With regard to roads, the following figures were given showing the road mileage in the Island Continent :

Main roads	35 000	miles
Developmental roads .	7 000	»
Other roads	238 000	»

It is stated that of « other roads » only about 50 % are actually formed roads.

It is roughly estimated that the capital cost of the road system was approximately £150 000 000 and the expenditure on maintenance in 1927/1928 amounted to £10 000 000 a great proportion of

which sum was expended on the upkeep of main roads.

The number of motor vehicles in use on these roads was as under :

Cars	406 000
Motor cycles	84 000
Commercial vehicles	75 000
Total. . .	565 000

During the same period of time the proceeds from the taxation of motor vehicles amounted to £3 620 000 and, in addition, there was an import duty of 2 pence per gallon on petrol, and of the £2 000 000 contributed by the Commonwealth Government to the States Governments as contribution towards the upkeep of roads it is stated that the greater portion of this sum was provided by the import duty referred to.

The Committee then proceeded to state that throughout Australia transport services have been provided whose capacity for movement of passengers and freight is greater than the volume of business flowing and that undoubtedly the losses to the State Railways due to motor transport probably amounted at that time to between £2 000 000 and £3 000 000 per annum.

The recommendations made by this Committee are of considerable interest and I give below details of some of the chief points of interest to the members of this Congress :

1. The establishment of a Federal Transport Council of State Ministers, presided over by the Commonwealth Minister of Transport together with subsidiary bodies to investigate problems arising.

2. Co-ordination with a State :

a) All transport activities within a State to be grouped under one ministerial head;

b) The establishment of a co-ordinating authority responsible for carrying out the transport policy approved by the Government.

3. *Railway extensions.*

Railway extensions into new areas to be restricted and the road programme directed towards feeding existing railways.

4. *Motor transport.*

Public motor vehicles to be regulated and controlled by State Transport Co-ordinating Authorities. In addition to the payment of adequate taxation, wherever possible road transport to be co-ordinated with the railway system and act as feeder services.

5. *Road finances.*

Main roads should be financed entirely from the taxation of road users and the contributions of local authorities.

6. *Taxation of road users.*

It was considered that the most equitable form of motor vehicle taxation is a combination of vehicle and petrol tax.

7. *Regulation of road transport.*

Public motor vehicles should be regulated so that the service they render shall not cause uneconomical duplication of services already existing, and the granting of licences to public motor vehicles should be in the hands of a Transport Authority such as a State Co-ordinating Transport Authority.

The effects of road transport competition were naturally more pronounced in the States of Victoria and New South Wales than in the other States forming the Commonwealth of Australia, as in those States the population is denser and a greater degree of industrialisation has been attained while, of course, the presence of the great cities of Sydney and Melbourne have considerable bearing on the point.

Victoria.

In 1928 an Act known as the Motor Omnibus Act of 1928 received the Royal assent after being passed by the Parliament of Victoria and this Act did definitely provide for a very considerable measure of co-ordination in internal transport. Among the provisions of the Act were the following :

The Governor in Council may by order prescribe :

a) The routes within the Metropolitan Area (i. e. the city of Melbourne and the vicinity within a distance of eight miles of the corporate limits of the city) along which motor omnibuses granted regular service licences may ply for hire;

b) Sections, terminal points and stopping places on such routes;

c) The timetables to be observed and the fares to be charged;

d) The maximum number of omnibuses which may be licensed to ply on any prescribed route.

It was further provided that before any route is so prescribed the Minister should take into consideration the maximum number of motor omnibuses proposed, and should confer with the Railway Commissioners or any municipality concerned, or with any other such persons as necessary, and that he should satisfy himself that the condition of the roads is such as to be capable of carrying the traffic without unreasonable damage and that there are not sufficient other facilities available.

The licences necessary under this Act were divided into two classes, one being a regular service license and the other a special service license; a regular service license has to be obtained for any omnibus running on a prescribed regular route and it is enacted that a special service licence is applicable to omnibuses engaged in pleasure trips and other such journeys. The owner of a motor omnibus for which a regular service licence is granted must maintain a regular service in accordance with the licence and unless the failure to maintain such service is due to circumstances which could not reasonably have been avoided by the owner, the Licencing Authority may cancel the licence.

A metropolitan Roads Fund was also established into which all monies received from the additional fees provided for in this Act had to be paid, and at the end of every financial year the monies standing to the credit of the Fund are to be allocated and paid in such proportions as the Treasurer of Victoria directs, to the several municipalities upon any of the streets or roads of the municipal districts on which omnibuses are used.

Provision was also made in the Act for restrictions and regulations respecting the height, length and breadth of motor omnibuses, the maximum weight and maximum load to be carried, the type of tyres to be used, the provision and regulation of brakes, and all such matters. Insurance against any liability by way of damages in respect of omnibuses in case of injury to persons had also to be effected by the owner of every omnibus.

An advisory committee, consisting of five members to act in an honorary capacity was also set up and it was stipulated that the Members of the Committee should be :

a) One member appointed as representing a department of Public Works who shall be Chairman of the Committee;

b) One member appointed as representing the Victorian Railway Commissioners;

c) One member appointed as representing the Melbourne and Metropolitan Tramways Board;

d) One member appointed as rep-

resenting Councils of Municipalities concerned;

e) One member appointed as representing the interests of owners of motor omnibuses.

The Melbourne and Metropolitan Tramways Board were also empowered with the consent of the Governor in Council to use motor omnibuses to ply for hire within the Metropolitan Area and were required to pay into the Metropolitan Roads Fund previously mentioned, a sum equal to the amount which would be payable for fees under the Act as if the Board had operated the services under licence, as in the case of private enterprise. The foregoing applies only to the Metropolitan area, but further sections of the Act deal with urban and country motor omnibus services and apply to certain stipulated urban districts, while the Governor in Council may constitute new urban districts, as the circumstances may require, and for each urban district so constituted a Licence Authority was duly appointed. The authorities so appointed in the case of the urban districts definitely scheduled under the Act were the councils of the cities of Ballaarat, Bendigo and Geelong respectively. Such authorities may grant, with or without such variations and amendments as they think fit, or may refuse to grant any application for a licence for an urban motor omnibus operating within the district, while the other provisions are very similar to those applying to the Metropolitan area previously referred to.

It was also provided that the Victorian Railway Commissioners may, with the consent of the Governor in Council, operate motor omnibuses on such routes and subject to such conditions as the Governor in Council thinks fit, and that the Commissioners should not be required to obtain any license, but should from time to time pay into the Country Roads Board Fund a sum equal to the amount which would be payable if the services were operated by licence. The additional fees payable under this Act vary according to the circumstances, for example, in the case of an omnibus operating a route in whole or in part within three miles of the town hall in the city of Melbourne and not provided with pneumatic tyres, the fee would be calculated at the rate of £ 4-10-0 for each passenger the omnibus is licensed to carry, or £ 3-7-6 in the event of the omnibus being fitted with pneumatic tyres. In the event of an omnibus working a route no part of which is within three miles of the town hall referred to, the fee would be calculated at the rate of £ 2-5-0 and £ 1-5-0 respectively for each passenger the omnibus is licensed to carry, dependent on whether solid or pneumatic tyres were provided, and somewhat similar fees were payable in respect of the urban districts and also for touring omnibuses.

New South Wales.

In New South Wales legislation designed to co-ordinate transport and known as the « Transport Act of 1930 » was enacted, and the preamble of this Act stated that it was an Act « to provide transport Trusts for the regulation and control of tramway and omnibus transport and public vehicles in certain areas; provide for a Commissioner of Road Transport and the transfer to him of certain functions in connection with motor vehicles; to amend the Government Railway Acts 1912 to 1928 and certain other acts and for purposes connected therewith ».

This Act applied from its commencement within the County of Cumberland, embracing the City of Sydney, and constituting a district known as the Metropolitan Transport District of which the area could be extended by the Governor. Furthermore, it was specified that other areas could be formed by the Governor

causing a proclamation to be made applying the Act to such areas.

In so far as the Metropolitan Transport District was concerned a Metropolitan Transport Trust was constituted and it was enacted that this Trust should :

a) Be charged with powers, duties and obligations imposed by the Act and adopt all measures tending to ensure adequate supervision and regulation in the public interest of all public road transport and omnibus services operating in this district for the conveyance of passengers;

b) Take all necessary steps to co-ordinate all such operations within its district, mitigate wasteful competition and overlapping in service, and shall take such steps as in its judgment are essential to secure to the public safety regularity, efficiency and convenience of services at just and reasonable rates.

The Trust, and any other Trust which might be formed, were also given the exclusive right to construct, maintain, manage and operate tramways for the carriage of passengers within its district, and any powers previously conferred upon the Railway Commissioners with regard to tramways would become vested in the Trust; the Trust might also establish and construct a motor omnibus or any other road transport service for the carriage of passengers and such service could extend beyond the district of a Trust, but so far as such route was outside such district, the Trust would be subject to the provisions of any law regulating such a transport service.

The licensing and regulation of public vehicles for the conveyance of passengers and goods and the licensing of drivers and conductors was vested in the Trust.

A Commissioner of Road Transport was also appointed to be responsible for the execution and administration of the Act and this official became the Chairman of any Trust which might be established and was to be the medium of correspondence between the Minister, the Trust and the Roads Board.

The Metropolitan Transport Trust comprises seven members, one, the Commissioner, another appointed by the Governor to represent business interests and by virtue of office, Vice-Chairman, the remaining five appointed by the Governor. At a subsequent date the remaining five members of the Trust ceased to hold office and were to be replaced by elected members representing constituencies one of which was the City of Sydney.

Tramways.

The tramway undertaking previously administered by the Railway Commissioners and all lands connected therewith were to be transferred to the Trust, while, in regard to the carriage of goods, the Trust was empowered to prescribe conditions upon which such carriage was effected and could not be required to carry certain dangerous or objectionable commodities.

With regard to accidents, under the powers of this Act the Governor can order an investigation into any accident, and the Court so constituted may enforce attendance of witnesses, production of documents and so forth.

Provision is made for insurance by the owners of vehicles, while a further interesting feature is that the Trust may operate a service at the request of any municipality or local authority provided that the authority guaranteed to the Trust the payment of any deficiency of annual earnings in relation to annual expenditure including depreciation interest or sinking fund charges.

Privately owned omnibus service.

From a date subsequent to the operation of the Act, the Trust was empowered to control the running of all privately owned omnibuses engaged upon

passenger transport in the district of the Trust, and could grant, alter, or close any route, and cancel or suspend any service wholly or in part.

The owner of any omnibus duly licensed under previous regulation at the commencement of this Act was entitled to the issue of a service license for the route upon which the omnibus was plying without variation of fares or timetables, but every such service license expired at the end of a year, and if it was desired to continue such service, application then had to be made for a license, when the Trust would consider the necessity for such service, having regard to other facilities, including rail, and could then grant, amend or refuse such license as they considered fit.

The fee charged for a service license is based upon the nature and extent of benefit enjoyed by the holder of the license, the nature of the route traversed an the *effect upon any service provided by the Trust,* but in no instance shall such fee exceed an amount equivalent to £ 4 for each passenger each omnibus is authorised to carry, while the license fee may be fixed at a small nominal rate for experimental or developmental services.

With regard to the services operated by the Trust by means of motor omnibuses, an amount equivalent to what would be payable into the vehicle fund must be paid by the Trust as if the route were operated on the conditions of a service license.

Insurances.

All omnibus owners are required to effect a proper policy of insurance against all sums for which they might become liable by way of damages in respect of such omnibus in case of injury to persons or property.

Regulation and compensation.

Should the Trust determine that a route in respect of which a service license has been granted should be discontinued, or that such route should in the public interest be operated by the Trust, the Trust may cancel the service license, and under such conditions the holder of the license may require the Trust to assign another route when another such is available, and may arrange with the Trust to transfer the service license to such route. If, however, the holder of a license is not willing to operate another route, or the Trust is of opinion that such a route cannot be made available, the holder may require the Trust to purchase the motor omnibus, plant and estate used in connection with the operation of the route; any such omnibuses or plant shall be purchased by the trust at a price which shall not exceed the then replacement value of a similar vehicle or article, having regard to its age and condition, together with a sum equal to 10 % of such value, or, if the holder of the service license so discontinued, or his predecessor in title, was at the date of the commencement of the Act operating the route and an alternative route is not assigned then a sum equal to 25 % of such value. Any owner who might be aggrieved at the determination of the Trust might appeal to the Land and Valuation Court, and jurisdiction was expressly conferred upon such Court to hear and determine any such appeal.

Apart from appeals as to valuation and amounts payable by the Land and Valuation Court, any owner of an omnibus or any Municipal or Shire Authority aggrieved by any decision of the Trust with respect to the issue, transfer or cancellation, etc. of a service license or discontinuance of a route, or with respect to the amount of any annual service license, might appeal to the Transport Appeal Court consisting of a District Court Judge appointed by the Governor.

Further provisions of this Act which, however, do not so closely concern this Congress, deal with the registration of

motor vehicles other than public vehicles, while a considerable portion of the Act is also concerned with the provision of a Road Transport and Traffic Fund, into which fees, other than annual service license fees were to be paid and from which monies were to be disbursed in respect of police supervision and control, of road transport appeals, supervision, the expenses of the Traffic Advisory Committee and the expenses of the Trusts constituted under the Act, other than in respect of the transport services of the Trust.

A further fund known as the « Public Vehicle Fund » was also established, into which was to be paid the proceeds of the tax upon public motor vehicles registered under the Act and all the monies received for annual service license fees. This Fund is to be applied so far as the money is derived from the tax collected in respect of omnibuses to the Councils of the several municipalities and shires over whose roads are operated omnibus services and to the Main Roads Board of New South Wales. Further details are given as to the exact distribution of this and other monies received in respect of registration and licenses.

This Act was indeed sweeping in character and contemplates the control of all internal *passenger* transport by the State, but it was only the forerunner of a far more drastic Act passed by the Parliament of New South Wales under the premiership of Mr. Lang, in 1931, and know as the « State Transport Coordination Act 1931 ». This Act received the Royal Assent in August 1931 and came into operation on 1 November of that year. Under the Act the Governor may appoint a Board of four Commissioners which shall carry into effect the purposes of the Act. The Minister may direct the Board to investigate the administration or intended operations of the Railway Commissioners, any Transport Trust, the Commissioner of Road Transport, the Management Board or the Main Roads Board, and all these bodies are required to furnish to the State Transport Co-ordination Board all such information as may be required. Furthermore, the Board shall as soon as practicable, furnish to the Minister a report setting out the steps which they consider should be taken to secure the coordination of the activities of the following services : The Railway Commissioners, the Transport Trusts, the Commissioner of Road Transport, the Management Board and the Main Roads Board, and to provide for the administration and control of such service under one corporate body, together with a draft Bill for the legislation necessary to give effect to their report.

Under this Act public motor vehicles can only be operated subject to license and this provision has been made to apply to *commercial* vehicles intended for the conveyance of merchandise traffic as in the words of the Act :

> Any person who operates, who uses or causes or permits to be operated or used a motor vehicle for the carriage or delivery of goods (other than goods that are not intended for sale whether immediately or ultimately) or of goods sold by him shall be deemed to be thereby operating a public motor vehicle within the meaning of this Act and such vehicle shall be deemed to be a public motor vehicle.

Every person desiring to operate a public motor vehicle must apply to the Board or delegated authority for a license and in the application particulars must be given as to the route upon which it is intended that the vehicle shall operate, together with full details as to the type of vehicle, the number of passengers or maximum weight of goods proposed to be carried, and details respecting the registration of such vehicle under previous legislation.

The license granted for a public vehicle other than aircraft may authorise the vehicle for which it is granted to op-

erate only upon specified routes or only within any area or district specified, while with regard to aircraft, the license may also specify the route over which it is to operate or may specify a district in which it may work with the exception of certain specified routes.

The Board may determine in respect of any particular license or class of licenses, the fares, rates or charges to be made, and may also determine whether any vehicle is to be used for the conveyance of passengers only or goods only, or, in the case of commercial vehicles, whether only a specified class or description of commodity are to be carried, and in dealing with applications the Board shall consider all such matters as they may think desirable and in particular the following:

a) The suitability of the route or road;

b) The extent to which the needs of the district are already served;

c) The extent to which the proposed service is necessary in the public interest;

d) The needs of the district or locality in relation to traffic, the elimination of unnecessary services and the co-ordination of all forms of transport including transport by rail or tram;

e) The condition of the roads to be traversed with regard to their capacity to carry the proposed traffic without unreasonable damage;

f) The suitability of the applicant;

g) The construction and equipment of the vehicle,

and finally the Board shall have power to grant or refuse any application for a license or in respect of any vehicle or area, road or distrct.

Not only does the Act require all users of public motor vehicles to obtain a license but owners and users of public motor vehicles are also required to furnish a vast amount of information with regard to the working of the vehicles concerned. The holder of a license must keep books and records in respect of the passengers and goods carried, including a record of all journeys undertaken by each vehicle and must make returns in respect of such carriage and of the freight and fares.

With regard to payment in respect of licenses, the Board may in any license for a public vehicle authorising the holder to carry passengers, or passengers and goods, impose a condition that the licensee shall pay to the Board for each and every passenger carried by the public vehicle along a public street, a sum not exceeding 1 penny for each mile or part thereof of his journey; while the Board may in any license for a public vehicle that authorises the holder to carry goods or goods and passengers, impose a condition that the licensee shall pay such sums as the Board may determine; these sums may be differently ascertained in respect of different licenses and may be ascertained on the basis of mileage travelled, or any other method. If the sum, or sums, to be paid are to be ascertained in accordance with mileage travelled, they shall not exceed an amount collected at the rate of 3 pence per ton, or part thereof, of the aggregate of the weight of the vehicle unladen and of the weight of the load the vehicle is capable of carrying (whether such weight is carried or not) for each mile or part thereof travelled by the vehicle along a public street. If the sum, or sums, to be paid to the Board are not to be ascertained according to mileage the Board shall repay to the persons any monies received by the Board in excess of the amount that would have been payable to the Board calculated on the mileage basis described previously.

Certain exemptions are provided whereby a public motor vehicle solely operated for the conveyance of passengers and/or goods on journeys none of which exceed 20 miles in length, the Board may

on such conditions as they think fit exempt the licenses for the vehicle from the conditions requiring payment in respect of the carriage of passengers and goods; furthermore, where a public motor vehicle is solely operated in the carriage of goods on a journey to the nearest practicable railway station for the purpose of the carriage by railway of such goods, the Board shall also exempt the license for the vehicle from the above conditions. It is also provided that where a public motor vehicle carrying passengers and/or goods ought not to be subject to these conditions by reason of the state of the roads travelled by the vehicle or the transport facilities in the area served by the vehicle, or for any other reason, the Board may omit the conditions as to payment. Further the provisions of the Act require any person acting as an agent to be licensed and the Board can at its discretion grant or refuse any such applications. Appeals against the administrations of the Act and the Board may be made by any person to the Transport Appeal Court established under the Transport Act 1930 and referred to earlier in this report.

With regard to the amounts payable to the Board in respect of licenses and fees, these monies must be paid into the State Transport Co-ordination Fund established by the Act and the sum so accruing shall be expended by the Board in accordance with the Act. The cost of the administration of the Act has, of course, to be met, while, with the approval of the Minister, the Board may make payments out of the Fund as subsidies in respect of any public motor vehicle used for *providing feeder services to railways and tramways.*

Not only are license holders and agents required to furnish information in regard to the use of public motor vehicles, but unless exempted by regulations the owner or proprietor of any bonded store, warehouse, shop, store or receiving depot, must record in a prescribed form full and correct particulars of all goods carried or despatched by a public motor vehicle from such places and must produce the record for the purpose of inspection; but here again this section does not apply to a store, shop or other such place not being a receiving depot if all the goods are carried or despatched therefrom on journeys none of which exceeds 20 miles in length.

* * *

Finally, I may mention that by subsection it is stated that an authorised officer may seize any motor vehicle or books, records and papers in respect of which he suspects that an offence has been or is being committed against the Act and may detain the same pending an action and legal proceedings.

I imagine that this Act, which deals in such a drastic way with all forms of road transport, must be almost without parallel, and I understand that during its passage through the Parliament of New South Wales it met with most strenuous opposition and, in fact, has caused a great deal of public discussion. It is, of course, too early to appreciate the results of the Act, and such results are quite unknown to me at the present time but, without question, it is an Act which practically places the whole of the internal transport of the State under the control of the State though not necessarily under public ownership, though it would appear that such a development might reasonably be expected to follow. It hardly seems likely in my opinion that the model of this Act will be followed by other Countries and States at the present time except under very exceptional conditions, but it will be extremely interesting to watch the working of this Act and the effect which it has upon transport conditions and particularly upon the railway system of New South Wales. I understand that the New South Wales Government Railways do not operate road services even for the

purpose of providing collection and delivery services except in connection with the delivery of goods from destination depots to consignee in particular localities where the volume of traffic warrants the arrangement, such as at Darling Harbour in the City of Sydney.

Furthermore, combined rail and road services are restricted solely to defined tourist areas and in such instances the rates are based on the railway fare plus the motor fare.

Airway competition is at present limited to a service operating between Brisbane in Queensland and Sydney, New South Wales, the journey being performed three times a week. The air service fare for the throughout journey of 500 miles amounts to £ 7 as compared with the first class rail fare of £ 4-12-0 for the rail journey of 611 miles, but competition is in respect of the time of journey which occupies six hours by air and 21 3/4 hours by rail.

Under the State Transport Co-ordination Act which I have discussed at some length, all air services have to be licensed and come under the provisions of the Act.

The Railway Commissioners do not possess powers to operate air services as such authority is vested in the Federal Government of Australia.

Union of South Africa.

The Railways of South Africa, which are owned by the State, provide a very complete road transport system for the conveyance of passengers and merchandise, and this has in the past been subject to competition from other road transport interests.

In 1930, in order to regulate the competition arising from private road transport interests an Act was passed « to provide for the control of a certain form of motor transportation » and known as the « Motor Carrier Transportation Act (No. 39, 1930) ».

This Act provides in the first place for the appointment of a Road Transport Board consisting of three members appointed by the Governor General, none of whom shall be officers or servants of the Administration. Provision is also made for the appointment of a Local Board for each Transportation Area which may be proclaimed, each of the Local Boards consisting of three members.

In the case of a Local Board for a Transportation area or route not coinciding with, or falling wholly or for the greater part within the area of any one City Council, Borough Council or Town Council, one member shall be nominated by the Board and two members by the Administrator within whose province such area, or the greater part of that area, is situate; it is also specified that one of the members appointed by the Administrator shall be so appointed after consultation with all authorities or bodies having jurisdiction in respect of any public route within the area. In the case of Transportation areas coinciding with, or the greater part thereof falling within the jurisdiction of a City Council, Borough Council or Town Council, or an area which includes any Municipality, City or Borough with a population of more than 20 000 persons, one member of the Board shall be nominated by such Council, one by the Board and one by the Administrator within whose province such area is situate.

With regard to the functions of the Board, the Act defines these as :

a) To investigate any matter relating to Motor Transportation in the Union and to submit recommendations thereon to the Minister;

b) To determine from time to time the volume and nature of motor carrier transportation which shall be permitted to operate over any proclaimed transportation route falling wholly, or partially, within one proclaimed transportation area;

c) To receive and consider applications for motor carrier certificates, for motor carrier transportation over any such route, etc., and under its discretion to grant or revise such applications wholly or in part;

d) To consider any security or undertaking required as an insurance;

e) To suspend or revoke a certificate of transportation if the holder or his employees are convicted of an offence under the Act;

f) To hear and determine appeals arising from decisions of Local Boards;

g) To appoint such persons as it may require to assist in performing these functions under the Act.

With regard to Local Boards, the functions of these are, of course, confined to the particular transportation area concerned and relate to an investigation into any matter with regard to motor transportation in any such area and the submission of any such recommendations to the Board; Local Boards have also to receive and consider applications for motor carrier certificates for transportation within the area for which they are appointed and to deal with all such matters, while it is definitely provided that any persons affected by a decision of the Local Board may appeal to the Board against such decision and the Board may thereupon confirm, vary or set aside such decision, or substitute therefor another decision.

Any motor carrier certificate issued by the Board, or by a Local Board defines the class of transportation in respect whereof it is issued and the particular vehicles concerned, while the route along which, or the area within which the vehicle to which it refers may be used in transportation, are also specified. In any such certificate the Board or Local Board, may require the holder :

a) To operate any vehicle to which the certificate refers wholly between specified places and according to a specified timetable;

b) To publish the scale of charges accepted by the Board or Local Board when granting the certificate and to adhere to such charges;

c) To comply with such further conditions as may be prescribed by regulation.

Full provision is also made for the granting of temporary certificates for transportation of a temporary nature with regard to any particular event or an event on a particular date.

Subsequent to the Act any person who for reward conveyed any person by means of any motor vehicle designed to carry more than eight persons including the driver, or not designed exclusively for the conveyance of passengers, or conveyed any goods by means of any motor vehicle other than the personal effects of persons travelling thereon over any public road within, into or through any proclaimed area otherwise than in accordance with the provisions of the Carrier certificate granted by the Board, or by a Local Board, was guilty of an offence, but it was specified that if any goods which have been sold, or are being conveyed for sale, are conveyed by the seller by means of a motor vehicle owned by him in the case of delivery of those goods to a purchaser or to a place of sale or by that purchaser, in case of delivery to himself, such conveyance shall not constitute conveyance for reward within the meaning of the Act. Furthermore, exemption is made with regard to the conveyance of any farm produce from the farm whereon produced to the nearest railway station or siding, or to the nearest town or village, or vice versa, provided that no reasonable facilities are available for their conveyance by railway or by any motor vehicle in respect whereof a carrier certificate has been issued for, or along, the greater portion of the most practicable

route between such farm and such station, siding, town or village.

Any person who was upon the date of publication of the necessary proclamation engaged in motor carrier transportation in any of the proclaimed areas, and who satisfied the Local Board that such transportation was efficiently effected at a reasonable charge, was entitled to receive a certificate in respect of the vehicles used and the area, volume and nature of the transportation. If, however, the Board considered that the total transportation facilities were in excess of public requirements the Board could at any time after the expiration of a period of six months, cancel all certificates covering transportation over such route and issue to the holders fresh certificates so as to reduce the number of vehicles or volume or frequency of transportation, or to limit the area or route.

With regard to applications, it is specified that the Board must upon application for a carrier certificate being made, publish details with regard to such application and must afford any person an opportunity to oppose or support such application and must consider any representations made in regard to the matter. The conditions which the Board must consider when determining whether an application should, or should not, be granted, are similar in nature to those applying in other countries, and are as under :

a) Whether the applicant is likely to carry on satisfactorily the transportation;

b) Transportation requirements of the public... the question whether those requirements are, or can be, satisfactorily met by other transportation facilities;

c) The nature of the transportation to which the application refers and the reasonableness of the charges which the applicant proposes;

d) Whether the transportation to which the application relates will adversely affect or assist any other transportation facilities and whether it can be co-ordinated therewith in a manner economically sound and advantageous to the public;

e) Any other facts which may affect the question;

f) The views on any matter referring to any local authority concerned.

It is definitely stated that whenever in the opinion of the Board transportation facilities in existence in any area, or over any route, are satisfactory and sufficient to meet the requirements of the public, the Board shall not grant any certificate in respect of any further transportation within substantially the same area or over substantially the same route in competition with services already existing.

Further, provisions are made in respect of insurance or production of any such security or undertaking as may be prescribed by regulation which must be complied with before a motor carrier certificate is issued.

All monies received by the Board under the Act are to be paid into the Railways and Harbours Fund and also expenditure incurred in the administration of the Act is defrayed from that Fund. The Governor General is also given powers to issue regulations regarding transport and to prescribe the form of any document required under the Act for records to be kept by persons engaged in motor transportation and to specify returns and information to be rendered to the Board or any Local Board.

It is further prescribed that the provisions of the Act except in so far as insurance is concerned shall apply in respect of any motor carrier transportation operated by the Railway Administration other than the conveyance of goods wholly within an urban area.

By a proclamation issued with the Act 14 transportation areas were estab-

lished, while a number of transportation routes were also provided for. By regulation owners of any motor vehicle engaged in motor transportation were required to keep a correct record of all traffic conveyed on each trip with regard to the number of passengers carried and where merchandise is concerned the points between which goods are conveyed, the names of senders and consignees, the number of packages and description of goods and the weight of each consignment. A complete record has to be kept by the driver or conductor of each vehicle and must be available for inspection by an authorised officer, while a monthly statement has to be rendered to the Board or the Local Board giving a summary of the passengers and merchandise conveyed during the preceding month. This regulation also specified that the fee in respect of a passenger vehicle should be £ 4 per year and £ 2 per year for each trailer, while for a dual purpose or goods vehicle the fee should be £ 3 per year and £ 1-10-0 per year for each goods trailer.

It will be appreciated from the foregoing that this Act does definitely seek to secure the co-ordination of all internal transport on lines bearing a close resemblance to the Road Traffic Act now in operation in Great Britain, but it covers conveyance of merchandise and thereby differs from the position as it exists in this country.

I have no detailed information as to the working of the Act or the results which have been achieved, but undoubtedly it establishes a position under which wasteful and uneconomical competition can be eliminated.

India.

Road motor competition for the conveyance of passengers is present and indeed, increasing in India, but it is stated that there is little competition for the conveyance of merchandise. It is impracticable to estimate the loss to the railways caused by this diversion of traffic, but the Great Indian Peninsula Railway (G. I. P. R.) gives the following example of the decline of traffic by rail between Bhopal and Sehore, a distance of 24 miles by rail and 20 miles by road:

Half-Year ending.	*Passenger.*	*Earnings. (Rupees).*
30-9-1928	18 763	9 381
31-3-1929	16 125	8 068
30-9-1929	15 673	7 887
31-3-1930	13 143	6 552
30-9-1930	9 656	4 843
31-3-1931	6 372	3 215

The railways do not possess general powers to operate road services, although in certain towns motor vans are used for the conveyance of parcels between booking offices and stations, but generally speaking collection and delivery services are not provided.

It is the policy of the railways to combat road transport except where, by co-operation, the road can act as a feeder to the railway. As an example of this the G.I.P.R. state that an agreement has recently been concluded with a contractor who owns and operates a bus service between Talegaon Station and certain out agencies within 50 miles of the station, maintained by the railway.

The agreement relates to the carriage of traffic booked through from the out agencies to stations on the railway and vice versa. Through bookings for passenger traffic are provided, including a reduction of 29 % on the ordinary third class fare for the rail proportion of the journey. There is no direct booking for first, second and intermediate class passengers. Similar arrangements are made for the conveyance of luggage and parcels.

In this case the agreement provides, inter alia, that the contractor shall provide an efficient service of vehicles of a type approved, and that the Secretary of State (as owner and administrator of

the G.I.P.R.) may at any time inspect the condition of the buses, general equipment, uniform of drivers, and cleaners.

In regard to liability, it is also provided that the contractor shall: *a*) carry passengers, luggage . . . . . . at his sole risk and responsibility, etc.; *b*) indemnify the Secretary of State against all claims . . . . . . proferred against him by third parties, etc., and *c*) he shall insure in the joint name of the contractor and the Secretary of State his vehicles against accidents to passengers and to third parties, and against damage to property including partial or entire loss to a limit of 20 000 rupees for any one accident, but this shall not in any way limit his liability in respect of any such accident.

The control of road motor transport is a provincial subject, and each Indian Province has its legislation in regard to the matter. The actual supervision of specific services is more or less vested in the local Magisterial and Police Authorities.

Generally, it may be said that the legislation is on the following lines :

a) An annual examination takes place before the renewal of license as to the condition of vehicles, and their fitness, or otherwise, for public service;

b) There are restrictions as to size and weight of vehicles necessitated by the state of bridges, etc.

The maximum capacity of omnibuses is also fixed and penalties are prescribed for overcrowding;

c) Maximum fares are prescribed by the Local Authorities and on competitive sections it is stated that the railway fare is generally the guide;

d) Taxation by way of license is determined by the various Provincial Governments;

e) Generally speaking, omnibuses are licensed to operate on specified routes and between specified points.

With regard to the position of the railways and the fixing of rates, the Government of India (Railway Board) prescribes a schedule of maximum and minimum charges for passenger and goods traffic, which railways are free to vary at their discretion, subject to general statutory provisions in the matter of undue preference, etc.

In practice, however, and as far as the State managed railways are concerned, the Railway Board prescribes the general scales of fares to be followed for the different classes of passenger traffic, but Administrations are free to reduce these charges to meet road competition between specific points, if such action is considered necessary, provided that the prescribed minima are not infringed.

In this connection, it has to be remembered that the position of the railways in India is peculiar. Practically all the important railways are owned by the State and four of the most important systems are under direct State management.

The revenues from the railways constitute an important contribution to the Exchequer of the Central Government, and it is of paramount importance, therefore, that the railways should be self-supporting and be able to maintain this contribution, otherwise the Exchequer would be burdened with the charges and other liabilities which the railways have to meet.

The diversion of railway traffic to road service on any large scale would be, therefore, a diversion of public revenues to private interests and the deficiency resulting would have to be made good in the end from other sources of Government revenue.

Airways.

Although India is connected with Great Britain by Imperial Airways, the development of internal air transport is in its infancy, and at the present time,

therefore, it can be said that there is no competition between airways and railways.

Sudan.

In the Sudan there is no organised road competition but individual natives have purchased cars on the hire purchase system and are carrying a certain amount of passenger and goods traffic to the detriment of the Sudan Government Railways.

It is not possible to estimate the losses that have been occasioned in this manner but it is the policy of the railway system to combat such competition. No restrictions are placed on the operation of road vehicles, although it is necessary to obtain a license and a quarterly mechanical examination by a Government Board is enforced.

With regard to airways, the Sudan forms a link in the Imperial Airway service operating from London to Cape Town, and, although the service is in its infancy, between certain places it does offer considerable advantages on account of the enormous saving of time. It is stated by the Government Railways that the journey from Juba to Shellal by rail and river steamer requires 19 days, whereas by air the journey is undertaken in three days. At the same time the actual carrying capacity of the air services is extremely limited and at the moment the diversion from rail to air is negligible.

Kenya and Uganda.

In Kenya and Uganda road competition is present, but it is not organized and is usually conducted by individuals owning single lorries. Even then, such competition is limited, as the operators are unable to cope, for example, with heavy agricultural crops. It is estimated, however, that the annual loss of revenue to the railway by reason of this competition amounts to £ 80 000.

The Railway Administration is empowered to operate road services, subject to local bye-laws, but only one service is operated as a link for the conveyance of passengers, mails and merchandise between the steamboat service on Lake Kioga and a similar service on Lake Albert (a Nile route to the Sudan).

No agreements have been entered into with those operating road services, except in respect of cartage and delivery services in certain centres.

The road services are not in a position to compete with the railway for the conveyance of passengers over long distances.

Legislation has recently been introduced in regard to road transport and by Ordinance No. 23 of 1931 a Road Transport Control Board was established for the Colony and Protectorate of Kenya providing that any person who desires to « use a motor vehicle for the transport of goods for reward from any scheduled place to, or to a place beyond, any other scheduled place » must make application for a license.

A number of important centres have up to the present been scheduled, and the Board may grant a license subject to such conditions as they think fit, or may refuse an application. It is also stated that the Board shall give regard to the following matters when considering applications :

a) The condition of the roads forming the route;

b) The extent to which the proposed service is necessary or desirable in the public interest;

c) The adequacy of existing facilities;

d) The needs of the area to be served... the elimination of unnecessary and unrenumerative services and the co-ordination of all forms of transport, *including transport by rail.*

It is, however, stated that « it shall not be lawful for the Board to refuse an ap-

plication *solely* on the ground that existing railway facilities between the places proposed to be served are in the opinion of the Board adequate to carry the goods or merchandise which the applicant proposes to carry ».

A further section provides that applicants must satisfy the Board that a suitable insurance policy has been effected.

Fees are scheduled payable in regard to licenses and it is observed that these are of a sliding scale dependent on the weight of the vehicle and the points between which it is proposed to run them.

Airway competition also exists for the carrying of passengers and mails, and is subsidised by the Government, but the traffic conveyed is regarded chiefly as new traffic. The advantage of air travel in this case is speed as, *e. g.* a journey of 257 miles requiring 19 hours by railway is accomplished in 6 hours. No steps to combat or co-operate with this form of competition have been taken at present, as the competition is not serious, but powers for the operation of airways could be obtained.

Nigeria.

In Nigeria short distance omnibuses and lorries compete with the Nigeria Railway for the conveyance of passengers and merchandise, and as an estimate of the diversion of traffic it is stated that this probably amounts to £ 5 000 per annum in respect of passenger traffic and £ 100 000 merchandise. The railway does not itself operate road services, except for the conveyance of merchandise to and from railheads, and in some cases these services penetrate 140 miles into the country.

There is practically no restrictive legislation, although certain minimum safety regulations have to be complied with before a license is granted, and there is no regulation of road fares and charges. The fares and rates charged by the railway have to receive Government sanction.

In the case of goods carried partly by rail and partly by road, as between Apapa and Sokoto, 725 miles rail and 136 miles road, common carrier liability applies to each part of the transit and the total charge is the sum of the two rates.

It is the policy of the Government Railway to combat road transport, but it has not, it seems been necessary to introduce any special measures at the present time.

There is no airway competition with the railway, although recently a seaplane service has been introduced, but this covers areas served by sea communication.

Malay States.

In the Malay States, as in many other parts of the world, there is no organised road competition with the Federated Malay States Railways, but local concerns operate lorry and omnibus services between villages and towns in the various districts. It is unusual for individual concerns to possess more than two or three vehicles.

The railway has sanction to operate road services and does run an omnibus service between Seremban and Bahan, a distance of 40 miles. This service was introduced when a branch line train service between Bahan and Kuala Pilah was terminated early this year (1931). The road service has, however, been run at a loss, and it is proposed to discontinue it at the end of the year.

The policy of the railway is to combat road transport by reduction of rates, but, at the same time, it co-operates with road motor owners by engaging these as contractors to perform collection and delivery services at all the large centres throughout the system for the purpose

of effecting combined rail and road transport.

There is no restrictive legislation as regards road transport, a license being issued free from any special conditions, nor is there any regulation of charges. It is stated, however, that there are no restrictions upon the railway as to the charges levied by them.

Ceylon.

In Ceylon, road competition exists both as regards the carriage of passengers and merchandise, but as a whole such competition is not organised and is of a « free lance » character, although there are a few established services working to timetables with published fares and rates. It is not possible accurately to estimate the loss to the railway due to such competition, as on the whole railway traffics do not appear to have decreased more than the decrease of the general trade of the Island. A rough estimate, however, is that 15 % of the traffic which was at one time conveyed by railway now passes by road, and this applies both to passengers and goods.

The Ceylon Government Railway does not at present operate any road services, though it possesses the necessary powers, nor does it have any financial interest or agreement with road concerns. Endeavours are, however, being made to get road traffic operators to take up feeder contracts with the railway, and it is thought that these are likely to succeed in view of the general reduction which has recently been made in goods rates.

Legislation exists in the Island in regard to the licensing of road vehicles, as to the weight, type of vehicle and inspection of vehicle, but these regulations do not effect the competition which exists, and it is stated that there are many breaches of these regulations which render them largely ineffective.

There are at present no airways operating in the Island.

Gold Coast.

Native owned lorries compete with the Government Railway system, but as the competition is unorganised and indiscriminate, it is difficult to estimate any losses which the Railway may have suffered. It is the policy of the railway to combat road competition, and no special powers would be necessary to operate road services, although none are actually operated.

There is no restrictive legislation in regard to road transport in this Colony, and airway competition does not exist at present.

Iraq.

In this country there is no organised road transport competition but a great deal of competition does arise from the activities of individual owners of vehicles who charge extremely low rates, allowing for no depreciation or other overhead charges. Frequently it is stated, the cars are acquired on the instalment system and run until they only possess a scrap value. Needless to say the standard of comfort provided for passengers in road vehicles of this description is extremely low but the cheapness of travel is the only factor considered by the poor class of passengers in Iraq. These competitors mainly cater for passengers and high value parcels traffic but recently a number of high capacity vehicles have been imported and these are competing with the Iraq Railway system for long distance merchandise traffic. It is not, however, possible to estimate the losses caused to the railway system by this competition owing to the rapid decrease in freights of all kinds due to the general economic position.

The Iraq railway system needs no spe-

cial powers to operate road services and in consequence it maintains and operates short distance services between certain stations and towns when the stations are some distance from the town. It also operates road services reaching out into the country beyond railheads.

By this means, and by the reduction of fares and charges, the railways endeavour in every way to combat the competition arising from the activities of « free lances », which are not restricted or regulated by any form of legislation.

With regard to airways Iraq is directly connected to Europe and India by Imperial Airways and in a sense the services thus provided are competitive with the railway system. The railway on the other hand probably benefits considerably from the introduction of the airway as by means of this rapid form of transport business men from Europe make more frequent visits to Iraq and Persia than they would otherwise make and this leads to improved general business and traffic in merchandise.

The railway system is not concerned with the airway nor has it powers to operate air services.

Argentina.

Extensive road competition for the carriage of both passengers and merchandise is present in Argentina, and, as regards merchandise, road motor services work up to distances of 300 km. from Buenos Ayres, despite the fact that in the country districts beyond a radius of some 60 to 70 km. from Buenos Ayres the road consist of a plain earth surface, levelled and fairly well maintained, unless heavy rains occur.

There is, however, no competition for long distance passenger traffic.

The road services penetrating far into the country chiefly convey general merchandise, and petrol, and return to the city with empty drums, wool, hides, cream and poultry, but no actual estimate of the losses is available, although it is the policy of the railway companies to combat such competition.

The railways, according to the laws of Argentina, are not authorised to undertake road services *working as a railway company*, although they may, and do, have interests in road concerns.

Road collections and delivery services are not directly operated by the railways, but agreements are entered into with suitable operators.

There is no restrictive legislation governing road transport, but authorisation is necessary for the operation of motor buses.

The Government, it is stated by the railway companies concerned, has not attached the importance to road transport that its recent growth merits in the opinion of the railways, but it is considered that in due course the situation will necessitate such consideration.

Railway rates cannot legally be altered without authorisation from the Government.

With regard to airway competition, this does not exist at the present time.

Manchuria.

In this country, road passenger services are operated by the South Manchuria Electric Company parallel to railway services provided by the South Manchuria Railway Company to a certain extent.

The company concerned is affiliated to the railway company, although the latter do not have any concrete method of control, or work jointly with the former, as apparently the competition is not of importance.

An airway operates between Dairen and Tokio, constituting a parallel route as against the railway through traffic arrangements maintained in collaboration

with the Chosen and Japanese Government Railways, but the question of competition is negligible.

Conclusions.

Railways and roadways.

It is clear that in nearly every country, competition for the conveyance of passengers and merchandise exists between the railway systems and road motor transport, organised or unorganised; it is also obvious, and indeed logical, that such competition is most severe in densely populated, highly industrialised countries, of which the chief, so far as my report is concerned, are Great Britain and the United States.

In these two countries the effects of road motor competition have undoubtedly caused the great railway systems very heavy losses and, from a purely railway standpoint, the position is uneconomical and wasteful. The argument can, however, be carried a stage further, for, in the opinion of many competent observers, the losses caused by such wasteful competition tend to, if they do not already constitute, a drain on the economic life of the community itself.

Let me quote a few lines from the introduction to the Final Report of the British Royal Commission on Transport:

> At first regarded as complementary, road transport soon became highly competitive with rail transport, and this, accentuated by the depression in the heavy basic industries and the staple textile trades — an unfortunate feature of recent years — has created problems not peculiar to this country alone. If allowed to continue unchecked, or uncontrolled, the full results of this competition will become even more serious, and will not only adversely affect the financial stability of those who provide transport facilities but will also hamper the development of trade and the economic progress of the Nation.

Those words, I think, express perfectly the position which would arise in the not far distant future in Great Britain and the United States, and subsequently in other lands, unless wasteful competition is eliminated and replaced by a proper system of co-ordination, letting each form of transport play its proper economic part for the good of the community.

Placing road transport on economic basis.

I do not think there can be any doubt that the first step is to place road transport on a sound economic basis — for this alone would, in fact, considerably reduce the amount of competition as it would automatically involve an increase in charges for carriage by road. To-day road transport can, in some instances, offer rates considerably lower than the equivalent railway charges, making it appear that road transport is, in fact, cheaper than transport by rail. This, however, is largely a fallacy and is due to the fact that the road transport industry does not bear the whole or a proper proportion, of its charges and responsibilities — in fact it transfers them to the taxpayers and ratepayers — the community. Examine the cost of highways for example. Conclusion No. 1 reached at the XIth Session of this Congress (question XIII) contained the following paragraph :

> To attain this end (i.e. co-ordination of service) it is necessary to modify the present position of road motor transport, which in most countries gives it an advantage over the railways, to make road transport bear its full share of the road expenses of which it is the cause...

Since that conclusion was arrived at the Royal Commission on Transport has considered the problem as it applies to Great Britain and the facts as outlined in the Final Report are, I submit, worthy of note :

> The ascertained facts are simple and, expressed in round figures easily borne in mind.

The total annual cost of the highways in Great Britain is £60 000 000; towards this the ratepayer pays £40 000 000 and the motorist £20 000 000. That is to say, the ratepayer pays two-thirds and the motorist one-third of the annual cost, but the £20 000 000 paid into the road Fund does not represent the total of the taxation paid by the motorist, since one-third (about £5 000 000) of the proceeds of taxation on private cars and motor cycles does not find its way into the Fund. In addition, the proceeds of the petrol tax towards which the motorist contributes (about £14 000 000) remain outside the Fund; these are paid into the Exchequer and are used for general purposes. Therefore, taking these additional sums into account, we find that the motorist is paying £ 40 000 000 a year, a sum equivalent to two-thirds of the annual cost of the highway system. Further, in 1927 the Road Fund was « raided » to the extent of £7 000 000, and in 1928 to the extent of an additional sum of £12 000 000, thus we find ourselves in the position of hearing the Highway Authorities say: « We are paying two-thirds of the cost and our burden is too great », while the motorist replies: « I am taxed to the extent of two-thirds of the cost and it is not my fault that the money is not spent on the roads ».

The Final Report of the Royal Commission, after further discussion of this matter, proceeds to the following finding and recommendation :

We are satisfied that the users of mechanically propelled vehicles are not, as a class, paying too much in taxation nor do we think that in a general way they are paying too little. But we consider that the ratepayers are bearing too great a proportion and that their burden in respect of rates is becoming intolerable. It is our unanimous opinion that, unless some relief is given, the improvement of the highways which is so necessary will be greatly retarded. We recommend that the present proportions should be reversed and that in future one-third of the cost of the highways should fall on the ratepayers and that two-thirds should be borne by the motorist. On the present figures this relief to the ratepayer can be given without involving any increase in the amount paid by the motorist if the amount now retained by the Exchequer from the proceeds of the taxation on private cars, as well as the proceeds of the petrol tax are credited to the Road Fund. We recommend, therefore that no proceeds of taxation (including the petrol tax) on mechanically propelled vehicles used on the road should be diverted from the Road Fund if such diversion involves a reduction of the amount contributed in respect of these vehicles to a proportion less than two-thirds of the total annual cost of the highway system.

It will be seen that if these recommendations of the Royal Commission were carried into effect no actual increase in total motor taxation would be necessary, but there would, of course, be a considerable relief to the ratepayer and hence to the railway companies of this country who are very considerable ratepayers indeed.

Subsequently, however, the Royal Commission dealt with the question of heavy commercial vehicles which undoubtedly cause a very great proportion of the wear and tear of modern roads and are thus responsible for an undue proportion of the amount of money spent in construction and maintenance of highways.

At the time of the Royal Commission the license duty payable in respect of such commercial vehicles varied from £ 40 per annum in the case of a vehicle exceeding 2 1/2 tons in weight but not exceeding 3 tons, to £ 60 in the case of a vehicle exceeding 5 tons, and it was stated by the Commission that, as a general principle, the use of lighter vehicles, say, 4 tons or less in weight, should be encouraged in the interest of highways, and that the use of vehicles in excess of this weight should be discouraged. In this connection it was suggested that additional steps at each ton should be provided for the purpose of taxation and

that at each step there should be a substantial increase of the duty payable. The Royal Commission continued : « We do not propose to recommend the adoption of any particular scale but we see no reason why the duty payable in respect of a heavy motor car with an unloaded weight of between 9 and 10 tons should not be as high as £ 120 per annum. »

If this recommendation is considered with that relating to the allocation of the revenue obtaining from the taxation of vehicles and petrol, it will be appreciated that while it would not involve any increase in the total of taxation the actual incidence would be altered so that the users of heavy commercial vehicles would be called upon to contribute a larger share of the sum expended on the maintenance of the highways.

This, however, does not constitute the whole of the charges which should, very properly, be borne by motor transport. Modern conditions have, for example, immobilised a considerable proportion of the Police Force who are called upon to act as traffic controllers. It can be argued that these men when so employed are safeguarding the life and limb of the public at large — very true — but it is the incidence of motor transport which has made such provision necessary.

Again, municipal and local authorities have expended large sums of public money on free parking places, and it is by no means apparent that such provision is always a benefit to the ordinary ratepayer.

If the whole of the relevant factors were taken into account a very considerable bill indeed would be presented for payment to the road transport industry, and I feel sure that, sooner or later, the truth of this will be recognised, if indeed it is not forced upon those in authority by the reluctance, or perhaps I should say, inability, of ratepayers to meet the demands made upon them.

Equality of conditions.

Since the Congress held in 1930 some steps have been taken to place road and rail transport on a more equitable basis. In Great Britain the various Acts of 1928 gave the railways generally powers to operate road services, and these, as has been seen, are now widely exercised either directly or indirectly. In the United States the railways generally do not possess such powers, but they have concluded agreements constituting subsidiary companies, securing more or less the same end. In the British Dominions and Colonies overseas the railways which are owned by the State either possess such powers or could readily obtain them if such a course were desirable, but in some countries the railways are still debarred from participating actively in road transport.

Finally, in this country the Road Traffic Act of 1930 has radically altered the position so for as *passenger* transport is concerned . (The effect on merchandise traffic is not nearly so pronounced.) This Act has, in fact, opened the door to co-ordination and stopped the transport speculator who was able to skim the cream of the traffic when and where he pleased with a minimum of responsibility.

It is of interest to note that this legislative measure places the transport of passengers in Great Britain on a firmer basis of co-operation and co-ordination than is the case in most of the other countries mentioned in this report, and it seems certain that it will serve as a model for legislation in other countries.

The Ordinance published in Kenya in 1931 shows evidence that the legislation of the Mother Country has been closely studied and applied to the very different conditions in that Colony.

It is in regard to the road transport of merchandise, however, that the position is not nearly so satisfactory, and it will be convenient to deal with this

aspect under the heading of co-ordination.

Co-ordination of road and rail services.

The co-ordination of road and rail services should be achieved so that each mode of transport fulfils the function which it can perform most efficiently and economically, and in preparing any such scheme for the co-ordination of internal transport it is necessary at some specific stage to decide the economic function of each service.

Many attempts have been made to define the proper functions of the two modes of internal transport with which we are here concerned. It has, of course, been stated that road motor transport is most suitable for short hauls and the movement of commodities in comparatively small quantities, while railways are specially adapted to long distance haulage and the transport of passengers or merchandise in bulk. Some authorities have gone even further in this direction and have attempted to define the actual distances over which it is, for example, more economical to employ one form of transport rather than the other.

To my mind such generalities do not appear to be of great value in deciding the problems which confront transport authorities in all countries at the present time. We are not dealing with a map showing a country without means of transport on which we propose to indicate ideal transport arrangements, but with countries in which transport has been developing for centuries — in which road and rail transport is present to-day — and in the case of countries such as my own and the United States, on a huge and complex basis.

It seems to me, therefore, that the problem before us is to deal with the specific rather than the general — with the particular needs of individual services as they affect the interests of the community and the providers of transport.

It is possible to secure such co-ordination in various ways. If, for example, the whole internal transport of a country is vested in one authority, then that authority can, in time, secure a vast co-ordinated system of transport, though there would be many difficulties to be overcome, and intricate machinery would have to be established to safeguard the interests of the users of transport and the community in general.

Such a course is envisaged by those who seek the « Nationalisation » of transport. The germ of nationalisation took root in the days when, so far as internal transport was concerned, the railway systems enjoyed a virtual monopoly. The circumstances of to-day are far removed from that condition, however, and « rigid » nationalisation has correspondingly decreased, so that to-day we find three schools of opinion.

1. National ownership and operation of all forms of internal transport.

2. « Rationalisation » of all forms of internal transport under a huge public utility trust or corporation.

3. A combination of the above, embodying ownership by the State but operation by a public corporation not politically controlled.

In theory, each of these plans would ultimately enable wasteful competition to be eliminated and replaced by a properly co-ordinated system of transport, but the difficulties would be immense, and it may be doubted whether any complete national plan will be adopted by any country for many years to come, although in all probability, sectional progress will be made in this direction, as has been indicated in the case of the proposed London Passenger Transport Bill.

There remains another plan. I refer to a system under which the State sets up an authority to license particular forms

of transport and specific services, and without whose authority such services cannot be operated.

As I have shown earlier in this report, systems embodying transportation by license have been introduced in Great Britain and in a number of the States forming the British Commonwealth of Nations.

The extent of the systems varies considerably. In Great Britain the license system only applies to passenger transportation (the reasons for this are discussed later in the report) and the system as at present constituted cannot be described as prohibitive of private enterprise.

In Victoria the system is very similar in many ways, while in the Union of South Africa the system covers the transportation of merchandise and is possibly somewhat more stringent than that in operation in this country.

In New South Wales the system covers every form of internal transport and aims at complete State control and a very large measure of State ownership; in fact, the restrictions placed upon private enterprise are so onerous and the charges which can be levied by the State so prohibitive that undoubtedly the system seeks to secure not only the elimination of competition but the elimination of private enterprise.

Transport of merchandise.

It will be appreciated that to secure a full co-ordination of transport the license system should be applied to the transport of merchandise, and I propose, therefore, to discuss this aspect of the problem.

In the first place only a proportion of the commercial road transport on the highways is employed in the haulage of goods for all and sundry (not necessarily common carriers). It has been estimated that in Great Britain only 20 % of the commercial road vehicles fall in this category — the remaining 80 % being used for the conveyance of the goods owned by the proprietors of the vehicles.

I have no corresponding figure for other countries, but undoubtedly in all densely populated and industrialised countries the same state exists, and it is apparent at once that this renders extremely difficult any plan to co-ordinate completely the transport of merchandise.

The vehicles employed by persons or firms for their own use, would be subject to any increase of taxation or to any legislation affecting the hours of work of the employees, but it is extremely difficult to see how such vehicles could be « nationalised » or « rationalised » or even subject to any restriction such as a « service » license, without causing great political ferment. At the present time there remain, therefore, the vehicles engaged in the conveyance of merchandise for reward only, in the case of Great Britain some 20 % of the total vehicles, to be dealt with by any scheme designed to secure co-ordination of transport.

The evolution of any scheme designed to place even this portion of road transport on an economic and equitable basis presents problems of great difficulty; in fact the Royal Commission have been unable to formulate any definite plan for Great Britain except to suggest that road hauliers, who, as it has been stated, own 20 % of the total number of commercial vehicles, should be registered with the Area Traffic Commissionners.

In the Final Report of that Commission the commercial motor vehicle is compared to a « tramp steamer » and the motor omnibus to a « liner » and surely the comparison is very true. Like the « tramp » the commercial road motor has flexibility of operation which is one of its prime, if indeed it is not its chief, asset. It cannot be denied that in certain circumstances flexibility — the power of going anywhere at any time — does confer a great advantage on this

form of transport, and, indeed, on the community at large. Hence any restriction of this freedom — and even a licensing system would be such — must tend to reduce the natural advantage referred to and might conceivably, not only retard the proper development of road haulage, but also harm the interests of the community. Thus it is that the Commission in question could only see their way to recommend a system of license which would ensure that the vehicles employed were suitable and fit and that the conditions of the men employed were just.

There, for the moment at any rate, I think we must leave this aspect of the whole subject of co-ordination and turn to the measure of co-ordination which can be achieved by the railways themselves.

Measure of co-ordination achieved by railways.

In the majority of the countries dealt with in this report the railways have now either powers to operate transport services on the highways or can enter into agreements with road interests giving them an effective measure of co-operation.

We have seen in individual countries that the railways have, in fact, made rapid progress in securing co-ordinated services by rail and road, and the steps taken have all been on sound and logical lines. It is not, I think, necessary to recapitulate the various steps which have been taken as I have dealt with these at some length under the heading of the country concerned, but perhaps I should mention, as a matter of interest, that a study of the progress made during the past few years, shows that the development follows very closely the matters discussed in the final summaries of the XIth Session.

Reference was made at that Congress to the various restrictions imposed on railways which were not suffered in a corresponding degree by highway transport, but it must also be agreed that the railways, in the days of their virtual monopoly, did, in fact, impose a number of conditions themselves. At the time these conditions were undoubtedly desirable and necessary, but in these days of competition some of the conditions referred to have become onerous, and may even be harmful, to the railways themselves. Flexibility under modern conditions is essential and there is ample evidence to show that Railway Administrations in every land have realised this and have taken steps to place their undertakings on a more flexible basis and to relieve themselves of forms of restriction or onerous conditions which may have been desirable in the past but are not essential to-day, and this is a process which is receiving daily consideration so far as, for example, my Company is concerned.

In conclusion, I feel that even during the short period which has elapsed since the Madrid Session the need for a fuller measure of co-ordination and the elimination of wasteful competition in internal transport has been realised by the public in whose hands ultimately lies the future prosperity, not only of transport, but of Nations.

Railways and airways.

The relationship between railways and airways is not altogether comparable to that existing between railways and roadways. Airways, of course, do enjoy a great superiority over railways as regards speed of transit, and it is probable that the speed of commercial aircraft will increase in the future although the cost of operation will doubtless be considerable.

At the same time, however, airways are limited in their operations. The load which can be carried is comparatively

small, and this, coupled with the high cost of operation, limits their activities to the conveyance of passengers, to whom the time saved by airway travel is of value, and of urgent mails and parcels. Furthermore, airways, paradoxical as it may seem, are not completely flexible. While aircraft, when the need arises, operate under extraordinary conditions, as in the case of the evacuation of civilians from Afghanistan some time ago by troop-carrying aircraft of the Royal Air Force, the operation of a regular commercial airway involves the provision of extensive, and indeed, expensive, aerodromes, and if night flying is required the provision of beacons throughout the route; finally, the advantage of speed only becomes apparent when the journey is over a considerable distance.

Nevertheless, airways, assisted by direct subsidies from the State, or by heavy mail payments, have already developed on broad lines, particularly over those routes where the distance involved enables air travel to effect a great reduction in journey time, such as, from London to Egypt, Iraq and the East, and from the Eastern seabord of the United States to the Middle West and the Pacific Coast.

The commercial development of airways has taken place slowly since the great war — and largely within the last few years — so that the railways — by then aware of the effects of road competition — were fully alive to the possibilities of this new competitor, so that despite the recent growth of airways, a very large measure of co-ordination with the railway systems has already been achieved and in the early part of this report I have dealt with the actual means employed.

No man can say what further development may take place in regard to the improvement of air-craft and engines but I do not think as railwaymen we need view such progress with any sense of alarm, as simultaneously with technical progress so will there be progress towards a complete co-ordination of services to the ultimate benefit of railways, airways and the community alike.

[625. 61 (.0]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

12th SESSION (CAIRO, 1933).

QUESTION XII :

Co-ordination of operation as between heavy and light railways.

REPORT No. 1

(Continent of Europe),

by L. JACOBS,

Directeur général adjoint de la Société Nationale des Chemins de fer Vicinaux (Belgium)

CONTENTS :

The question of co-ordination between the large and the secondary railways with which the present report deals is a somewhat delicate one. The heads of organisations who have attempted or are attempting to harmonize the two systems are well aware of the complexity of such a problem.

It would even be allowable to doubt the possibility of reaching any conclusions if it was a question of judging by the fate of the questionnaire which we prepared with a view to drawing up our report. Of the 131 railways to whom this questionnaire was sent, 32 gave us a well studied and informative reply ; 13 said they had no answer to give ; and the remaining 86 did not consider it any good answering at all.

Furthermore, of the 32 replies received, only 12 were from secondary railways, though 63 such railways had been asked for their opinion on questions that concern the very life of their industry.

We asked ourselves what could have been the reasons leading so many of them to refrain from answering.

It might have seemed valueless to reply to our questionnaire, either because there was co-ordination in certain cases and those concerned did not think it worth while to let us know their methods and the results obtained ; or because there was neither possibility or hope of arriving at such co-ordination. But it might also have seemed to some that the very acuteness of the question, the diversity and sometimes even the

antagonism of the interests concerned, made the position a rather delicate one, so that it might even be ill-considered to take sides publicly.

However, we restricted ourselves to an objective examination of the question set: co-ordination between railways for the transport of passengers and goods, especially from the point of view of transfer from one railway to another; co-ordination of equipment; the part that could be played by road motor vehicles in co-ordination; relations between railways in order to achieve co-ordination.

However, we do not pretend to have exhausted the question on all these different points of view, each of which have been dealt with under one very definite aspect. This method of procedure, however, did not prevent us from coming up against many contradictions. This would not be a bad thing, provided it resulted in discussions from which light might be thrown on these knotty points. The very diversity of the replies we received on any single subject is a sufficient proof of how easy it is to hold different opinions as regards the meaning of the terms used and of how much confusion is possible.

Everything depends on the angle from which a question has been studied from the beginning.

Therefore, before beginning a study of the practices demanded by a co-ordinated working of railways, it is of the utmost importance that the exact spirit in which such co-ordination is to be understood be made quite clear.

* * *

At the very outset it must be said that under no circumstances is co-ordination to be looked upon as a mere pretext or panacea. Under the label « Co-ordination », so fashionable nowadays, those financial or political operations, with which it has nothing in common, are not to be classified.

To co-ordinate does not mean to combine to subordinate, to absorb, or to annihilate; neither is it the finding of a remedy capable of curing all kinds of grave ills, such as those resulting from the present world crisis, both financial and economic. It seems to us that co-ordination is the application of essential economic principles; it is a necessity that has become more clearly defined under the present difficulties and which will be effected under the pressure of facts.

These facts are too present and play too great a part in the whole problem of co-ordination of transport for it to be necessary to analyse them at length.

* * *

It can be affirmed without fear of contradiction that the motor services have been allowed to develop with practically absolue liberty by means of private initiative which legitimately seeks for lucrative enterprise; practically no directing force or restriction of public interest has been placed on them.

This liberty, or rather this license, has made possible the most pernicious parasitism to the very detriment of the community.

In the first place, the existing public services have had to suffer considerable loss which could not but react, often very gravely, on public finances.

Secondly, the accumulation of different competitive services to supply the same demand has brought about duplication which results in unjustified immobilisations of capital; the growth in these during the last ten years has had a very adverse effect on the general economics of many countries.

Let it be clearly understood that there is no question of our regretting the growth of the road motor services, but simply and solely of pointing out that the anti-economic direction taken by this development should be condemned as prejudicial to everyone.

It would not be reasonable to want to fight the road service simply and solely to profit the railways. It is part of the evolution of the technique of things that could not be foreseen and we needs must follow this evolution and not try to prevent it or hold it back ; that would be a sheer loss of time. The only thing the railways can logically demand is that the competitive transport methods should be charged in just proportion with burdens equal to those that weigh so heavily on the railways.

If it is permissible to deplore the fact that only too often governments or competent public authorities have through lack of foresight allowed a situation to arise which today causes them so much trouble, it must be recognised that they have many excuses for not having given this problem all the attention it deserved, seeing that most governments were face to face with those difficulties that since the war have not ceased to crop up, such as the restoration of the devastated areas, industriel re-equipment, financial difficulties, economic disorders, and finally the world crisis.

It is these same facts that have unfortunately retarded the evolution of the railway in so many places, we mean the adoption of more modern equipment which would have met traffic requirements and the demands of the public and so in some measure have defeated the unjust competition tolerated.

Furthermore, it is a moot point whether the railways, had it not been for the crushing losses inflicted on them by the serious business crisis, would not have taken such steps as would have defeated this illegitimate competition altogether.

Neither can one be sure that without these frequently disastrous deficits governments would have had their attention so forcibly drawn to the fact that the transport problem is one of general interest and to the necessity of recognising this economic truth, so misunderstood, and yet so simple, the imperious question of co-ordination.

We are not unaware that in the domain of the great railways and the secondary railways different sorts of co-ordination can be considered.

According to the stand taken: whether technical, administrative, economic, or social and political, widely different points of view present themselves.

However, by concentrating on the solution of the technical problem and the financial problem, the general economic problem is seen to dominate the other two, so much so that it would be impossible to arrive at a really reasonable conclusion without first of all defining the conditions it lays down, the limits it sets. Furthermore, this problem of economy has itself to take into account the social needs and the greatest common good of the nation.

Before proceeding to the actual study of what it is necessary to do technically and financially in order to co-ordinate the workings of railway companies, we will try to pick out whatever is rational and realisable in this principle which we have just enunciated.

* * *

We do not think that we could find any one who would contest the opinion that all co-ordination should be a function of the general interest and that it is in consequence the duty of governments to take steps to see that this is so, to encourage all that tends towards this end and to prevent all that might impede co-ordination thus understood.

If such a principle is set forth the inevitable consequences can at once be seen. Some of these are as follows :

1. In a given country it is necessary for the whole of the population to have at its disposal transport services suited to the needs of the entire country as well as to regional and local needs.

2. The cost of transport must be kept as low as possible, and care must be taken not to adopt any method of transport which for equal loads raises the prices and is a burden to the general economics.

The rule should be to try to lower the net price enough for the users to profit thereby in a tangible way, either by lowering the rates, especially for goods transport, or by improving the frequency, speed, comfort and convenience of the service. That indeed is the proper object of co-ordination.

3. It is known that in most countries the large and secondary railways have agreed to carry a large proportion of their passenger traffic at very reduced rates. This practice, fruitful from a social as well as an economic point of view, is often of considerable importance. In Belgium, in particular, 75 % of the passengers carried by the railways in 1928 benefited by these reduced rates, and 56 % of these passengers were season ticket holding workmen who pay a bare 4 Belgian centimes per km., i.e. 0.57 gold-centimes. These reduced tariffs result in the average receipts per passenger-kilometre being 12 Belgian centimes, i.e. 1.71 gold centimes. In the same country the same remarks can be made in the case of the National Light Railway Company. Now, how can it profit the community if the competitive methods of transport by duplicating such services deprive the railway of precisely those passengers who pay the full rates, leaving it only the others ? The present balance, beneficial as it is, would be destroyed because the railways would be obliged, if they are to continue to exist, to raise the reduced rates.

That would undoubtedly be a serious disturbance which finally condemns the duplication dealt with above, just as it shows the baleful effect of incomplete solutions dictated by a narrow spirit and miscomprehension.

4. From this consideration as much as from the consideration of the other services rendered to the community — by which we understand all those indirect benefits that have accumulated from railway activity during so many years, a whole century in fact — it can be concluded that in the general economic interest the railways must be safeguarded because in every country they form an important part of the national patrimony. In the very measure in which their constitutions are founded upon a disinterested spirit and that their activity is devoid of any seeking after unreasonable gain and is applied to the realisation of the general good, the public transport services by rail form an economic and social factor which not only must not be done away with, but which could not with advantage be replaced by anything else.

5. All the same it goes without saying that the railways must not, under the pretext that they have an imprescriptible right to exist, think that they are exempt from the obligation of keeping up to date, and without having taken any pains to adapt themselves to present day traffic requirements, pretend at one and the same time to benefit by their old prerogatives — even while allowing themselves to perish of inanition — and to practise a co-ordination consisting in subordinating those railways who were already bringing themselves right up to date and doing their best to respond to the economic exigencies of the moment. Such an understanding of the case would be directly contrary to the general interest and could not be defended for a single moment.

6. If it is agreed that the general interest, the welfare of a country should have the advantage over more limited interests, no matter how legitimate these may be, what power other than the widest, i. e. the government itself, should be given the charge of taking the neces-

sary measures for ensuring this. Generally it is the government, the natural defender of national interests who grants concessions and authorizations, and therefore it should be its business to put order into things and in consequence to co-ordinate.

Regional and local authorities cannot be expected anymore than the transport enterprises themselves, to place the organisation of the general economy among their very first considerations, unless the law giver thoroughly conversant with the benefits of co-operation, of mutuality and of a disinterested spirit, has given such institutions a constitution founded on such high and broad principles.

However, it must be said downright that regional and local authorities as well as transport enterprises content themselves with furthering the prosperity of their own sphere of activity; by so doing they are only carrying out their proper functions.

It is the business of the State to look after the general welfare.

7. Obviously this vigilance on the part of the governments which corresponds to a right of the people must on no account degenerate into interference which may easily become an abuse, even a tyranny, and which would not be more desirable than allowing transport companies and regional and local communities to act, or not to act, entirely as they please.

Such an interference would be just as harmful as no restriction at all and as the absence of a general view, the lack of which is only too well-known in the domain of transport.

This means that some equilibrium must be found, a difficult but not impossible task, and that the intervention of the State must not assume the character of a guardianship. By reason of its high position the State owes it to itself to play a watchful part, a part which no one else can undertake, rather than an active part for which there are many aspirants. It is for it to guide and encourage, to temper and gainsay when necessary; its duty is at one and the same time one of impulse and supervision, it consists rather in suggesting than arresting, in calling forth initiative than in impeding what is already tending toward the co-ordinated service of the community.

Indeed, has it not been obvious, in these last years, what happens when the State neglects its mission ?

Either because it has neglected to limit private initiative which is often haphasard and more concerned with lucrative results than the general good, or because it has not foreseen its shortcomings, and, to sum it up in a single word, each time it has neglected the practice of a healthy co-ordination, the State has been responsible for many serious wrongs.

* * *

There are indeed many public men who at the present time have a very clear understanding of the situation and its exigencies and who are perfectly agreed with the principles we have just enunciated. Quite recently in France the President of the Ministerial Council, Mr. Laval, after having stressed the grave symptoms revealed by the losses sustained by the railways and after having indicated the measures which he thought would improve this situation, admitted :

There is a whole policy of construction required.

Six months later, in explaining the financial situation of the railways, and their increasing losses, to the Chamber (1), Mr. Laval enumerated the causes

(1) Meeting of 27 January 1931.

of these losses and indicated among others :

Motor competition which above all takes from the railways the most productive kinds of traffic...

Furthermore he was only corroborating the opinion expressed some time before by the Minister of Public Works, Mr. Deligne. This latter did not hesitate to stress the fact before a Committee of the Directors of the great French Railways that the rural districts were those most interested in putting into force modernised and co-ordinated operating systems.

Finally, 4 December 1931, the Prefect of the Seine, before the General Council which had to decide on the question of public transport in the Paris district, spoke as follows :

No one denies that a general reorganisation of transport is necessary and that it should put an end to the economic competition that is so dangerous to departmental finances. Nor does any one deny that co-ordinating and harmonising both above and below ground is necessary for the steady carrying out of the great works needed for the public good not to be slowed down... Here we are all full of good will, inspired with the sole object of the public interest and with a profound conviction that a general reorganisation of transport is the basis of rational, economic and social development...

The English tendency is the same, as is proved by the report published in 1931 by the Ministry of Transport on the electrification of the main lines, from which we take the following remarks :

All services that are generally useful to industry and commerce should evidently in their projects of development and their hopes of prosperity take into account the general industrial and agricultural progress of the country... In a country in which productivity is increasing it is a self-evident axiom that the transport services must be directed towards progress, to the ever increasing improvement of its methods, proceedings and its operating results... A railway company when operating on modern lines and getting good results is already and always will be a vitally important element in the life of the nation.

In Germany there is a similar feeling. Measures of co-ordination between rail and road have already been taken in the sense of relative equalisation of transport tariffs by rail and by motor, and Dr. Gutbrod, Secretary of State for the Ministry of Transport, after having shown how the economics of the whole country benefited by a lowering of railway rates, concluded an article on the question by these words :

It must be understood that co-operation between these two methods of transport (rail and road) would be the most healthy solution for the public good (1).

Finally in Belgium, the government is far from ignoring the necessity we have described.

In 1928, Senator Lippens, our first Minister of Transport, stated in the report to the King, in which the creation of a High Council of Transport was proposed :

The development of each method of transport must take the others into account, and the necessity for co-ordinating the efforts of transporters is required in order to avoid fruitless competition and to bring about a better output from the means already in existence (2).

Two years later the same Minister defined the policy of transport as follows:

1. As far as each method of transport taken individually is concerned : to improve its

(1) *The Métropole* (Antwerp), 12 January 1931.

(2) 10 July 1928.

organisation and its equipment so as to obtain the maximum economic output;

2. To co-ordinate the different methods of transport (by water, rail, road and air). Public interest requires that instead of a rivalry that is often burdensome, a wide co-operation should be aimed at in order to obtain fast and cheap traffic. Co-ordination would make possible a rational use of the enormous capital invested in transport equipment; avoid waste and duplication due to unrestrained competition; it would make possible a judicious distribution of the financial effort; it would reduce the burden of the cost of transport which weighs on national economics.

Each method of transport has its own policy. Thus in the case of the railway it must first assure fast transport over long distances and secondly create many junctions between the chief and secondary railways.

As far as goods are concerned, the traffic must be speeded up and intensified (1).

The views of the present Belgian Minister of Transport, Mr. Van Isacker, in this respect dot not differ from those of his predecessor as his recent words show:

At present it is admitted nearly everywhere that the policy of free competition has had its day. Such a policy has revealed itself to be disastrous to the transporters as well as to the users. It cannot indeed give the safe, rapid and cheap transport that the public has the right to demand. We should therefore endeavour to find in a policy of co-ordination the solution of this important transport problem, assigning to each transporter the traffic which he is best able to carry out under the best conditions.

It was to this end that the Ministry of Transport was established. Its essential task is the co-ordination of our transport methods...

A healthy co-ordination gives indeed two benefits: it gives the traffic to that method of transport in existence which can carry it out most economically and at the same time see that it does not compromise the existence of other methods of transport...

It would be anti-economic to allow the road services to take traffic away from the railways even if in certain cases, because of special circumstances, the road services could offer lower rates.

It would be against public interest because in taking away from the railway the more remunerative kinds of traffic it would make it impossible for it to grant those reduced rates to workmen as well as to goods of small value which are so necessary for our industries.

It is chiefly because these principles have not been observed in most countries that the railways are now faced with such great difficulties (1).

It would be a mistake not to cite in this connection Mr. Renkin, the present Prime Minister of Belgium, who as Minister of Railways, in January 1919, declared in words implying the idea of co-ordination:

All the methods of transport depend one upon the other and have the same interests, all should tend towards the same end. The more methods of transport the better; because transport facilities arouse greater activity, improve the free circulation of goods, develop industry and commerce, and in consequence public prosperity. To try to set them against each other is unthinkable. I know it has been said that there can be industrial competition between the local railways and the State railways, but this is a pernicious and dangerous error. There is no such thing! I know that this idea has held sway; I know that it has led to difficulties from which we are still suffering; I know that it is a capital mistake which has also led to secondary

(1) Belgian Senate, 20 March 1930.

(1) Conference given in Brussels, 26 January 1932, to the « Jeune Barreau » (those newly called to the Bar).

errors. I take this opportunity of informing you that I am determined to combat all such errors (1).

What do these different declarations, based on great economic truths and inspired by the necessity for co-ordination, lead us to conclude ?

It is that there has never been a more favourable atmosphere for a general solution of the transport problem and that it is for the technical men and the heads of such enterprises to do their utmost to ensure prosperity in this same spirit.

This is the task which we have undertaken to do as best we may in so far as that part of the problem dealing with the co-ordinated operation of the great railways and the local railways is concerned.

* * *

As we had to form an opinion on the subject of co-ordination as already realised and the methods used to bring it about, enquiries were sent to various great and secondary railways of continental Europe.

We have to thank very sincerely those Companies who were good enough to reply, some of them extensively, to our questionnaire. In particular we wish to mention the Great French Railways including the Nord Belge Railway, the Swiss Federal Railways, the Italian Railways, the North of Spain Railways, and the Madrid-Sarragossa-Alicante Railways, the Netherlands Railways, the Portuguese Railways and the State Railways of Norway, Poland, Sweden, Jugoslavia and Bulgaria.

We much regret that about 100 other railway companies did not consider it worth while replying.

It must also be said that what co-ordination was pointed out to us was more or less exceptional and at any rate often more apparent than real.

* * *

I. — Exchange of goods.

From the replies received it is evident that the importance of direct relations between secondary lines and the great railways is nearly always misunderstood, and in consequence their joint relations are often neglected.

Certainly the great railways declare that they are in favour of co-ordination, that they have already achieved it, and above all that they have largely contributed towards its realisation to a greater or lesser degree.

These secondary railways who replied to our questionnaire also favour co-ordination, but state that unfortunately they can get no assistance from the great railways.

Characteristically, in those rare cases when we received replies from two railways, primary and secondary, exchanging traffic with each other, the opinions expressed were often different and even contradictory.

It is for this reason that we have stated that the cases of co-ordination pointed out to us were more apparent than real.

This is not because of any shortage of exchange traffic. Looking at the figures for 1930 we find that for four great railways : the Paris-Orleans, Paris-Lyons-Mediterranean, Nord and French State Railways, over 30 000 km. (18 650 miles) of 1.435-m. (4 ft. 8 1/2 in.) gauge railway, there are 174 exchange points with secondary railways of the same gauge, and 401 with railways of metre gauge, so with 5 252 804 t. exchanged there were 9 100 t. at each exchange point; and for the 3 300 064 t. transhipped, 8 000 at each point of contact be-

(1) Special Meeting of the S. N. C. V. (Belgian National Light Railway Company), 7 January 1919.

tween the metre and the standard gauge railways.

The Polish State Railways have 74 points of contact between 1 759 km. (1 093 miles) of standard gauge lines and 3 705 km. (3 022 miles) of narrow gauge lines; between these two railways 87 744 wagons were transhipped, i.e. practically 1 200 wagons at each junction.

In Switzerland the Federal Railways with a 1.435 m. (4 ft. 8 1/2 in.) gauge and a length of 2 431 km. (1 510 miles) exchange 2 047 503 t. at 138 different points, i.e. 14 900 t. or 4 wagons a day at each junction.

In Belgium where 50 % of the railways are light railways of metre gauge, 2 953 880 t. were exchanged in 1930 at 144 junctions with the 4 792 km. (2 978 miles) of. 1.435 m. (4 ft. 8 1/2 in.) gauge lines of the Belgian National Railway Company.

In Spain the Madrid-Sarragossa-Alicante Railway Company states that of its total exchange tonnage, 6 969 579 t., 1 229 072 t. were transhipped.

In Finland, 50 000 t. per tranship point were exchanged and 7 000 wagons per junction.

In Jugoslavia the chief standard gauge railway [6 910 km. (4 294 miles)] and the narrow gauge light railways of 1 m. (3 ft. 3 3/8 in.) and 0.76 m. (2 ft. 6 in.) [700 km. (435 miles)] exchanged 696 868 t., 490 189 of them by transhipment at 7 junction points.

We would have liked to extend the list of exchanges between railways, but unfortunately very few companies replied to this question.

However these suffice to show that a light railway often concentrates a great deal of its goods traffic at a junction.

Now it is obvious that in the case of railway transport it must be possible to count on heavy, abundant and bulky traffics in order to have low cost prices and be able to offer the users the most advantageous rates, the determining factor in the choice of the method of transport.

Nevertheless an exchange of goods between railways of the same gauge and particularly between railways of different gauges considerably increases the cost of transport and can even make it prohibitive. Tranship equipment and arrangements are often far from scientifically and economically designed; the indispensable minimum in the case of different gauge railways seems to be the construction of stages that bring the floors of the wagon to the same level or better still the provision of raised and sunk lines which will in the case of many commodities greatly speed up manual transhipment.

The magnitude of the tonnages we have just mentioned makes it seem as though in certain cases it would be worth while installing expensive equipment in the tranship stations, which would appreciably diminish the net cost of the work. However, in many cases the exchange tonnage is not great enough to justify the replacing of manual transhipment by mechanical methods, the first cost of these being prohibitive as compared with the volume of goods to be dealt with.

As a general rule wherever there are more or less perfected appliances, the royalties that have to be paid on them are too high for them to be of use in the development of the traffic.

The same applies to machines in everyday use : gantry cranes, cranes, weighing bridges, etc. Moreover it is regrettable that the great railways only rarely authorise the secondary railways to use the appliances.

The diversity of conditions and practices made evident by the replies to the questionnaire, which we will quote, at any rate showed quite clearly that if there is much to be done in this sphere it is also possible to do it.

In France, the « Chemins de fer de

grande banlieue » (Suburban Railways) told us :

Exchange by transhipment is done by hand. For this purpose we use our own equipment which is however very rudimentary.

The Paris-Lyons-Mediterranean (P.L.M.) said :

The junctions of the P. L. M. with secondary railways are of two kinds : *a*) stations « in common » in which the P. L. M. company carries out all operations including handling, the service being common to both the railways; *b*) stations with separate services in which each company has its equipment quite distinct from that of the other and does its own work; in these latter stations it is the secondary company that carries out the transhipment of transit wagons. In the first case; stations in common, the P. L. M. company uses its equipment and appliances for the transit service. In the second case — separate services — the secondary railway uses its equipment and appliances.

The Paris-Orleans Company stated :

When the junction is worked on a joint basis, the great railway as manager carries out the handling of goods exchanged with the secondary railway; the appliances of the great railway as well as its equipment are used for the needs of the secondary railway who bears part of the general expenses. When the two railways have separate stations, the goods are usually handled by the narrow gauge railway.

In this case it is not possible to use the appliances of the great railway for exchange purposes.

The Indre Tramway Company (metre gauge) uses no mechanical devices except stationary cranes for heavy articles. Transhipment is made from one wagon to the other on two parallel tracks conveniently close together. The handling is done by the company's servants except at Vierzon and Blan where the Paris-Orleans does it. Except in these two last stations the appliances of the great railways are not near enough to the exchange stations.

In the case of the Ain Tramway Company, the great railway does not place any appliances at its disposal.

The Lunéville-Blammont Railway (metre gauge) carries out transhipment for itself and by its own staff. In the way of appliances it possesses a 5-ton gantry crane and a 3-ton crane. The great railway does not lend it anything but takes the wagons to the exchange siding of the secondary railway where this latter returns the rakes already coupled up.

The Deux-Sèvres Departmental Tramways (metre gauge) consider that the most efficient of their exchange appliances and equipment are transporter-trucks which make it possible to run large gauge wagons on narrow gauge lines. The appliances of the great railway (cranes, platforms) are placed at their disposal. The lines used for transhipment are hired by them.

In Switzerland, the Federal Railways have special equipment for the exchange of complete wagons with narrow gauge railways. This consists of transporter-trucks and the addition of a third rail to the narrow gauge line.

Cranes are placed at the disposal of the secondary railways or of the concession holders charged with the transhipment, sometimes free of charge, sometimes at a reduced rate.

In Finland the equipment of the great railways is placed at the disposal of the secondary railway, sometimes free of charge, sometimes on payment of an indemnity.

In Spain the Madrid-Sarragossa-Alicante Railway Company carries out transhipment and all services connected therewith for itself.

In Holland, the facilities granted by the great railway depend upon its interest in the secondary railway as an auxiliary service.

Finally the Portugese Railway Company has no special equipment for the

exchange of goods except a transhipment gantry at Espinho-Vouga. In its opinion it would be useful to equip tranship stations with mechanical appliances.

All this shows sufficiently in what way co-ordination can be and should be understood.

* * *

It is also recognised that, in principle, whatever the railway concerned, two lots of buildings, water columns, track, stock, wagons and locomotives or shunting engines are no longer allowable.

To avoid an anti-economic situation all that is needed is a fair agreement which would be no harder to realise and no less fruitful between great and secondary railways than it is between great railways.

The information furnished on this point was very instructive.

The Italian State Railways, when it is only a question of using stock belonging to the State railways running over secondary railways, have fixed the hiring rate at 0.30 lira per wagon-hour, no free time being allowed. In the joint stations the quota for shunting costs is included in the annual rent charged for the working. The secondary railway is directly in charge of this and also has to pay for the maintenance of the appliances set aside for its exclusive use.

In Portugal, the Companhia Portuguesa para a Construção e Exploração de Caminhos de Ferro (metre gauge), informs us that each railway has its own equipment. The transhipment appliances belong to this company.

In France, the Light Railways (metre gauge) inform us that wagons belonging to secondary railways containing or receiving incomplete loads are not run into the sheds of the great railway; their contents are transhipped by the secondary railway at its own expense.

In the case of the Paris-Orleans Railway, each railway carries out at its own expense operations on its own lines.

In the case of the French State Railways, the expenses are in common when the two railways are of standard gauge, but when gauges are different they both pay their own expenses. In stations of the same track gauge, all handling is carried out by the great railway.

In stations with different gauges, the handling is, in principle, by the secondary railway ; sometimes the great railway does it and charges for it.

* * *

A great many other reforms are still necessary.

The same offices existing side by side belonging to each railway with different and completely independent staff, complicated, expensive and useless papers dealing with dispatches and deliveries as well as joint checking, the drawing up of new way-bills, the daily balancing of accounts with an uncompromising exaction of fines, etc., are only a few of the many harmful practices still in use at the present time at many transit stations.

All these expenses greatly increase the total net cost of transport, raise the rates and finally drive customers away from the railways.

The following are examples of such pernicious complication.

In France, on the Paris-Lyons-Mediterranean Railway, in principle all consignments are entered up again at the transit stations, where new papers are made out for the route over the other railway's lines. No matter what the direction of the traffic, the dispatches to be made by the transferring railway are generally made in accordance with a special way-bill on which are entered on the one hand the sums to be debited to the corresponding railway (sums dues, payments made) and on the other the sums to be placed to its credit (part of transport to be allotted to it, carriage paid). The balance is made between

these two sums on consignment sheets made up in this way, and a settlement of accounts is made between the two railways either in ready money at the transit station or at the end of the month through a running account kept at headquarters.

In Belgium there are much the same formalities and a settlement of accounts is made daily by cash payments.

In Switzerland, in many stations the great railway assures the local services of the connected secondary railway. Those wagons of the secondary railway that come into the great railway's station have access to the goods sheds. The expenses are equally divided. Consignments are entered in an expeditions' book and the destination stations enter them in in an arrivals' book. No waybills are made out. In the case of small parcels there is a simplified form of entry and the sums due are collected by means of stamps.

In Spain there are two ways of organising tranship stations; that in which the service is common to the two companies, and that in which each company carries out its own work.

In Finland the great railway carries out all formalities, prepares all documents and deals with the settlement of accounts.

In Italy, when it is a question of transports from one of the stations of the State railways to be completed by another railway, the consignors must address their goods to the exchange station where they are unloaded and collected by the other railway who reconsigns them to their destination under a new bill. In these cases the settlement of accounts is made daily at the exchange stations.

In Greece, the Piraeus-Athens-Peloponnesus Railway (metre gauge) informs us that the chief railway as well as the secondary railway prescribe the same formalities for transports over both lines as for those over a single railway ; each railway draws up the necessary papers.

* * *

Co-ordinated working rightly understood and reasonably carried out could easily remedy many of those inconveniences which cause serious losses as far as general economy is concerned.

For example, many companies are too fond of making use of one-sided agreements. This results in exaggerated rents which indirectly affect the net cost. In the same way the division between railways of expenses for supervision, use of connecting sidings, transhipment, rents on land, track and rolling stock, among other things, usually only profits one of them. And very often this profit is a pure illusion because of its disastrous effect on the development and even on the retention of the traffic.

We will review some of the systems used.

In France, on the Paris-Orleans Railway, the expenses incurred in installing equipment for exchange purposes are borne by the secondary railway company. When this latter has not sufficient space round the junction to set up this plant, the Paris-Orléans rents it the necessary land on payment of a rent based upon the importance and value of the land in question. The secondary railway always owns narrow gauge equipment.

The Paris-Lyons-Mediterranean Railways, by applying the provisions of their regulations, always make the secondary railway pay the installation costs.

In the case of the Alsace and Lorraine Railways the great railway requires the secondary railway to pay the same rent and taxes for ground, track and stationary equipment used on connecting lines as those applied to all the great railway's wagons. The secondary railways of different gauge pay standing charges for the time the wagons of the great railway are kept on the transhipment sidings.

Nothing is paid for the first 24 hours the wagons are there. This period is doubled in the case of wagons received and returned loaded. Once this period has expired progressive rates are paid for the delay. The different handling operations are carried out by the secondary railway at its own expense.

In the case of the Deux-Sèvres Departmental Tramways, the great railway pays 50 % of the cost of installing exchange appliances.

In the case of the French Light Railways, land is let to them by the great railways at a nominal rent simply to ensure ownership.

The wagons of parcels traffic transferred by the great railways are charged from 3.50 to 6 fr. per unit. The cost of handling these same goods is calculated at the same rates as those enforced by the existing statutes. If the great railway requires certain modifications to be made to the equipment at the exchange point the secondary railway always bears the expense thereof.

In Italy the secondary railway has to pay an annual rent of 5 % on the value of the land used by it, which belongs to the great railway. When it is a question of handing over stock to the secondary railways, the hiring rate is fixed at 0.30 lira per wagon-hour for the whole period.

In Norway there are common stations and the secondary railways pay the State Railways a fixed annual rate for the privilege of using these stations and equipment.

In Jugoslavia the secondary railways pay the great railway a gold dinar for the land they use in recognition of its ownership. The parcels and baggage are transported by the handing over railway from one train to another or else together by the two railways.

In Belgium the local railways pay the great railways about 1 000 000 Belgian francs a year solely for the costs of looking after level crossings and as rent for land used.

On the German railways as a rule each administration accepts the dispatch and handling of goods in its own sphere.

The cost of equipment, sites and land used in common are considerable in the case of many of the exchange stations.

These are mostly borne by the exchange station itself.

Finally in the case of the Portuguese Railway Company already mentioned, each railway receives 5 1/2 escudos per ton transhipped though the actual transhipment is carried out by the secondary railway alone. As for the shunting done by the great railway to get the wagons to the tranship sidings, for all the goods transhipped at Espinho this latter is paid for 6 km. (3.7 miles) over and above the actual mileage. This surcharge paid by the consignor or consignee, causes a loss of traffic in the case of stations near Espinho in favour of lorries who transport the goods direct to and from Oporto, which is the chief centre of the district and only 20 km. (12.4 miles) from Espinho.

It is easy to distinguish among these customs those that are profitable from the point of view of the general good as well as for the railways in contact with each other.

* * *

If the part played by the secondary lines as feeders has sometimes been called in question — contrary to the accepted opinion — it is certain at present that were it not for these lines the greater part of the goods traffic which they manage to keep for the railway over small and medium distances would immediately fall into the hands of the motor lorries and be carried straight to their destination, i.e. without the assistance of any railway at all.

And since it is observed that motor competition is greatest in the case of short distances, especially near large

towns, i.e. precisely at the point of contact between the great railway and the local railways, it is not only indispensable, but even an urgent necessity, that these latter should really be treated as the easy and speedy extension of the great railway, for whom it multiplies the number of private sidings and the transport facilities.

The relations between railways and in particular between great and secondary railways on the one hand and tramway companies on the other should be increased so as to make it possible to serve directly the fruit and vegetable markets, general markets, breweries, iron and steel works, large building yards, etc., and deliver the goods to the spot.

The technical improvements to be made at exchange points vary naturally according to the type of transit station; generally there is an urgent need to do away with the divisions between neighbouring stations in order to imitate the effort already made by certain railways to give their feeders, the secondary railways, the right of « co-user » of the junction by putting at their disposal their lines and handling equipment, buildings, and goods sheds, stock and staff, always let it be said once more with the object of lessening the expense to their clients, a very efficacious encouragement, and of speeding up transport.

* * *

Exchange traffic can be classified into two categories :

a) That which would not be obtained by the great railway if the small railway did not exist;

b) That which would be carted to the great railway.

In the first case the small railway is an auxiliary of first class importance.

In the second the part played by the secondary railway in collecting and handing over the goods absolves the great railway from laying down wide gauge track, expensive goods yards for vehicular use, and the cost of lighting, supervision and maintenance of such installations.

There are important tranship stations where transporter-trucks are used of normal gauge, but especially of narrow gauge, which make it possible for the railway to give a sort of transport by containers, since the wagon on the different gauge truck takes the place of a mobile case. These transporter wagons ultimately should be able to take the containers brought up by lorries and should thus become more generally used.

Finally a great many railways need new equipment in order to make the junctions more useful and to assist in developing the traffic of the two railways. For this reason the great railway should recognise that it must take a fair share of the expense. As a matter of fact, thanks to the interchange equipment, it is freed from congestion of goods in the rush periods, it avoids much expenditure, draws direct advantages from the traffic brought to it by the secondary line, is dispensed from setting up new installations for its local traffic and has less expense to bear in the case of wagons destined for or coming from the interchange stations than for those that have to be loaded and unloaded in expensive installations with tracks, goods yards and loading platforms.

* * *

Under present conditions the railways no longer have a monopoly either in practice or by right. Therefore it is not apparent why the great railways should impose on their connections with secondary railways the same conditions as for private sidings and conditions even less favourable than those granted the motor lorries.

For example, to make a single organisation bear all the establishment and

maintenance expenses of lighting equipment is a policy which evidently must be abandoned as soon as co-ordination is considered. In a word, just as the great railways agree between themselves on these questions as associates, the great railways and the secondary railways could have a corresponding system of partnership and treat each other as collaborators.

* * *

Supposing that an agreement were made on the basis of an equitable division of the cost of the joint equipment, economies in the first cost of installation would at once result, as well as in maintenance and operation and this would at once enable the great railway to adopt special rates in favour of the goods traffic of the secondary railway, even if the motor lorry, master of its rates, which generally are a function of its cost, had not already made it necessary for the railway to reconsider its rates.

In such cases where it is a question of transports which logically should belong to the railway, it is legitimate and necessary, in order to take into account both the public interest and the interest of the companies concerned, that these latter should at once agree to transport goods of all kinds at rates corresponding to a reasonable charge for transport by motor lorry.

In localities or places not completely linked by railways there are often heavy expenses over and above the railway rates; this alone increases the popularity of motor lorry transport. In such circumstances everything goes to show that the railways should give the most favourable rates for the whole distance and furthermore organise, if need be, transports by road and railway so as to achieve door-to-door collection and delivery. To obtain such results, all that is needed is for there to be agreement between the different railways.

Also very often door-to-door collection and delivery at an inclusive rate is the necessary solution for services between districts served by railways and not far distant from each other.

The railways are unanimous in regretting the lack of elasticity in their rates; before these can be applied they must in effect be passed by the higher authorities. However, when motor transports are carried out at rates corresponding to those of the railway, the two railways should enjoy more liberty, not to make possible an arbitrary choice of rates, but to grant an immediate reduction when it is a question of keeping or developing their traffic. Provided these modified rates cover at least the expenses of each railway, transport at reduced rates for traffic between two railways facilitates by its very nature close collaboration between them and neutralises the competition of motor lorries where it is harmful to the railways without being specially beneficial to the districts served.

It should be possible for the two railways to grant these reduced rates quickly, without losing sight of the special conditions proper to each railway as well as the net cost of the transports in question.

* * *

The secondary railways carry out above all short-distance transports for which the division into classes is of little importance. Also for cartage the weight or bulk is often the only matter to be taken into consideration, whereas the ratio between the carriage rates and the fixed charges on the great railways is inverted in the case of the secondary lines.

For the secondary railways the average mileage of a wagon is small, about 15 km. (9.3 miles) in Belgium, while for the great railways it is about 100 km. (62 miles) and the constant element (the fixed charge) instead of being a second-

ary matter becomes of primary importance. Therefore it is not possible to force the secondary railways to adopt generally the rating methods of the great railways without a harmful or even ruinous effect on their economic position.

The difficulties in the way of arriving at a rapid and well adapted agreement for effective action show how very advantageous it would be to establish a simple system common to the two railways, co-ordinating their efforts, organisations, and installations, and looking out for all possible reductions in transport costs by making these proportional to the capacities of the two railways, and finally, organising common transport according to the most reasonable economic principles.

II. — The exchange of passengers.

If the necessity for co-ordination is no less evident in this sphere than in that of goods traffic, there are many who hesitate to do anything in view of the complexity of the situation. Some, however, have arrived at a solution. An objective examination of the facts will show not only if success is possible but also if co-ordination is necessary for the general good and if it forces itself on the railways.

The railways think that a speeding up of train services is one of the most important factors in keeping or increasing passenger traffic.

The people do in fact go to the quickest method of transport.

Now the minimum time taken by the trains of each railway to cover a certain distance is often added to by great and regrettable loss of time due to getting in and out of trains between two neighbouring points, which, though very near each other in reality are widely separated by ordinary or « administrative » barriers, difficulty in getting to the booking office for passengers on the secondary railways, slowness in issuing tickets at rush hours, the results of all of which is that even when the connections are considered good under present conditions at nearly all junctions a loss of time calculated as an average of a quarter of an hour must be allowed for.

Everyone readily admits that passengers with luggage have already much difficulty in changing from one train to another in the stations even with the aid of a porter. It is almost superfluous to remark how much in many countries these difficulties are increased when it is a question of passing from one railway to another. Narrow gauge lines especially seem not to have been built to connect directly with the great railway. In most cases their trains stop at a considerable distance from the great railway station. Sometimes the secondary railway stops alongside the main line platforms but on the opposite side of the buildings, from which it is fenced off. The passengers are thus forced to make a lengthy detour to cross the lines, either by a level crossing, bridge or subway. Yet in many cases it would be possible to make this much easier for the passengers. Often all that would be required would be a gateway enabling the staff of the secondary railway to take passengers to the booking office and inversely, for the same staff or that of the great railway to take passengers to the secondary railway. It is hardly necessary to say that through tickets or, better still, the issue of corresponding tickets in the actual trains would be still better.

The staff concerned and the public would quickly and easily get used to all this.

Every facility accorded to passengers reacts favourably on the two railways, though many are slow in admitting this because the results are not very obvious.

At times local conditions make it only possible to reach the station of the great railway by a level crossing ; unfortunately the great railways usually dislike having their lines crossed in this way, and this reacts in favour of the buses.

This difference in the treatment of the two methods of auxiliary transport is against all justice and is in direct opposition to the idea of co-ordination.

In certain great centres the situation is even more contradictory. There are no relations at all between the two railways as the companies have opposed the penetration of the suburban lines into the populous centres.

However it is flagrantly unjust to deprive the rural population of the benefits offered by secondary railways as well as by the bus services; there is no reason why services of local interest should not carry passengers to the main stations of the great railways without change of carriage as well as into the centre of the towns.

* * *

In their endeavour to find ways of effecting economy in motive power and staff, the great railways naturally try to assure better correspondance between their different lines, but very often they fall into the error of overlooking the operating possibilities and needs of the secondary lines.

If timetable modifications of the great railways are sometimes passed on to the secondary railways, it is exceptional that these latter can successfully ensure the most legitimate demands of the populations they serve being met, let alone their own operating requirements.

Yet the secondary railway also has to take into consideration the rational employment of its stock and the connections to be made not only with the different lines of the great railway which it crosses perhaps several times, but also with its own lines.

To reduce the failures to keep connections to a minimum, to revise periodically the connections, and to achieve this, to require formally the local staff to try to guarantee these connections in a close and cordial spirit of collaboration, constitutes a task of co-ordination, which it behoves both the great and secondary railways to carry out.

* * *

The general method of procedure in the exchange of small consignments, farm produce, etc., also stands in need of improvement. Very often, under present conditions, the secondary railway has not only to transport these goods at its own expense and by its own means (hand truck, barrow) from its own station to that of the great railway, but it has also to collect them from this latter's goods shed which is often at some distance from its terminus.

In these cases transhipment is carried out under conditions awkward for the staff, defective, slow and often harmful to those goods liable to suffer quick deterioration.

The result of these difficulties is that too great use is made of the accumulated delays in transport to the detriment of the users and in the end the road motor services profit.

Obviously it would be possible to remedy these inconveniences ; indeed we have been informed that certain railways have succeeded in so doing.

Here again, the system of co-transporters seems to be just as favourable to the two railways as to their clients.

* * *

On the other hand, it is not a question of introducing new practices but of arriving at making general the use of systems whose value in principle is well known. It is easy to cite examples.

Already in 1910, the commercial conference of the Association of Swiss Railways tried to find a remedy for the many inconveniences due to exchange services by drawing up a convention relating to the through transport of passengers, baggage, animals, and goods. Sixty-five

railway companies both standard and narrow gauge signed it.

Unfortunately we did not get any information, from interested secondary railways, on the application of through rates to the small lines. The Swiss Federal Railways however informed us that through tickets are issued (combined tickets) and, in conjunction with certain railways, through season tickets. The through tickets being made out for the whole journey, from the departure station to the arrival station the passenger is not obliged to get another ticket when changing from one railway system to another.

The two railways are not separated by any barrier and this eliminates loss of time and many of the difficulties in transporting luggage. Passengers get into and out of the trains directly from one platform to another, either by subways, or by crossing an open space or going through a building.

In the case of the transhipment of luggage, small goods, mail, parcels, etc., the better-equipped stations have special platforms for these services.

The Swiss Federal Railways inform us that it would be possible to improve the important station of Burgdorf by allowing the Burgdorf-Thoune railway's lines to come right into the great railway's station.

They also think that the secondary railway should always come within the station limits so as to facilitate the arrival and departure of passengers and assure the rapid transhipment of parcels and small goods.

As a matter of fact in Switzerland, in the most important centres, the secondary railways come right up to the stations of the great railways. The only exception is the Birsigtahl to Basle Railway.

As in most European countries, the working receipts of the Federal Railways show a deficit in comparison with those of the preceding statements. In 1930, they were 418 546 000 Swiss francs as compared with 431 357 000 francs collected in 1929.

The goods traffic shows a considerable decrease : 18 781 000 t. as compared with 19 675 000.

On the other hand, it is interesting to note that in the case of passenger traffic which is thus worked in through service there is an increase.

To sum up, the example of the Swiss Railways might well be imitated by every railway, not perhaps in every detail, but certainly in its main features.

In France, the question of a closer contact between the narrow gauge and the great railways is also a pressing one.

The Sud-Ouest Railway Company desires each of the two railways to issue through tickets and registers luggage through to the other at least in the case of the most used stations; at Toulouse there can be no contact with the great railway because it is too far off; the two railways are separated by barriers; the timetables have no connection with each other. A scheme under consideration will enable an improvement to be made.

The Ain Departmental Tramway Company states that access from its lines to the stations of the great railways is difficult and could only be improved at great expense. This Company thinks that a joint station is preferable to two stations in contact with each other, but that the distribution of costs is such that the secondary railway has difficulty in bearing the share put on it. The Company also fears that in the case of a joint station the staff of the great railway charged with examining exchange goods would be over-zealous for the interests of their own company and tempted to charge up all losses and damages to the small railway.

For these reasons this Company has decided against joint stations.

The Indre Tramway Company draws up its timetables quite independently of the other railways; it is moreover not

always possible for it to assure connections, especially at the ends of the same line; three of its stations are joint with the great railway.

The Deux-Sèvres Departmental Tramway Company has no joint station; however the exchange of parcels is carried out in the great railway's sheds.

It must be noted that for their part the French State Railways are trying to improve the working of these points of contact, especially those giving access to lines serving watering resorts. In the same way the Paris-Orleans Railway Company cites as measures likely to facilitate and speed up the transport of passengers and baggage between great and secondary railways, the issue of through tickets and the through registration of luggage.

The principle of such measures can be applied in different ways.

The Nord Railway Company for example issues through tickets the price of which is calculated by adding up the rates charged on each railway; with such tickets passengers get their luggage registered right through to their destination.

On the other hand, in Poland and Belgium, at several important places arrangements have been made to issue two tickets at once, the one to the terminus of the local railway, the other from the exchange station on the principal line to the destination station, and vice versa.

While affording greater facility to the public, this last system has the advantage of making control easy, the accountancy being more simple than in the preceding case.

It is interesting to note that the Nord Railway Company seems to have always tried to make the secondary railway come within the boundaries of the principal station; we have been informed of about fifty such cases over its system.

It even authorises the secondary railway to make use of some of its lines in order to enable it to reach either more important towns than those at which it actually joins the great railway, or railway centres from which results a greater facility in improving the connections it gives and receives.

When the gauge is different, the common section of track has four rails; the French Nord Railway possesses nine sections of track like this.

Without pretending that here there is a direct relation between cause and effect, it is interesting to note that while the greater number of the Continental railway companies state that owing to road competition the number of passengers has either remained the same or diminished, the Nord Railway has been able to state in its last annual report, in respect to passenger traffic :

The number of passengers carried by the Nord Railway Company in 1930 was 158 013 379, these figures being an increase of 4.3 % on those of 1929. There has been an appreciable decrease in international traffic owing to the diminution in the Anglo-French traffic and in that of workmen between Belgium and France, so that this net increase must be chiefly due to an increase in the French traffic and the internal traffic of the Nord Company.

* * *

The passenger's choice of transport methods is influenced undoubtedly by considerations of cost, comfort, safety, etc., but it is especially dominated by two other considerations very characteristic of our time: speed and frequency of the service.

Now the service of branch (secondary) lines of the great railways as well as those of the light railways themselves is at the present generally still covered by slow and heavy suburban trains which cause the companies concerned many serious technical and financial difficulties.

In order to carry a few passengers it

is necessary to use stock that is much too heavy in proportion and which requires the employment of a large staff.

If, mornings and evenings a rush of passengers seems to justify the continued use of very important equipment, a reasonable concern for economy obliges the company to reduce the number of trains during the day. The result is that the trains run almost empty while passengers favour the light and frequent bus services.

When one considers the numerous reductions in rates granted, the multiplicity of season tickets and the magnitude of the taxes weighing on rail transport in so many countries it is quite understandable why under these conditions suburban passenger transport should be for all railway companies, but particularly for the great railways, a cause of loss.

It seems that the time has come for a wide outlook, that is to say a just outlook. How is it possible to achieve co-ordination, which first of all means putting order into things in order to arrive at agreement afterwards, if one refuses to admit that all systems of co-ordination should be studied from the point of view of the general interest and in such a way as to do everything that can add to the general economy and to stop everything that goes against it.

During these last years much experience has gone to show that if the problem of co-ordination of the great and small railways is in no way theoretical but on the contrary extremely complicated because of the infinite diversity of conditions in practice, care must be taken to avoid putting forward as solutions regulations the more inapplicable as they are more rigid.

Now it is well known that a primordial concern for the general interest can get over difficulties that seem insurmountable. It is such a concern that arouses the desire or sees the necessity for friendly agreements which shall be capable of safeguarding what are so often common interests. Likewise it is such a concern that will inspire solutions as well balanced as they are due, perhaps at the price of willingly made concessions or sacrifices, to a desire to obtain the best output from each of the railways concerned, which were perhaps up to that time unavowed rivals.

This suffices to show that there is no question of calculations which under the pretext of co-ordination tend to favour the speculation or the desire of one railway to dominate over the other.

But on the contrary, the real solution is obtainable in the measure in which the railways, guided above all by a concern for the general good, economic as well as social, agree to try to examine each case in a finite manner.

Sometimes it will be necessary to suppress duplication, sometimes it will be a question of closer connection, and sometimes the development of certain districts will make necessary new services corresponding to their new needs, or simply more modern services.

Only the future can show us up to what point co-ordination thus understood should be carried.

As the railways handle new tools : electric coaches and light rail cars, the interpenetration and consequently the interdependence of the railways will be increased.

Moreover who would care to pretend that as the railways continue to specialise more and more they would not be obliged at the same time to come to a better understanding and to a real and closer collaboration ?

Evidently no one would, in theory, prefer decay and disappearance or decline through the always menacing competition, to fruitful collaboration or even one assured of small profits. And yet in practice such preferences are often found !

The idea of co-ordination has however

Fig. 1. — The « Micheline », French Est Railway.

made some progress. And if much remains yet to be done it is easy to see, from many indications, that every day there is a little progress.

In this way, little by little, the different kinds of transport will fall into their proper places, which had been upset these last few years, not so much because of the sudden development of the motor services as by the anarchy this sudden expansion momentarily introduced into the transport field, an anarchy only too often due to the inertia of the public authorities.

But at present, co-ordination going hand in hand with the modernisation of the great railways and the secondary lines will make it possible for the railways to occupy, or to be exact, to re-occupy their proper place.

On the one hand, the electrification of the railways operating the great services, and on the other the substitution of electric traction, electric or internal combustion engined rail motor coaches, trolley busses or even omnibuses for steam traction on lines serving suburban or rural populations, while showing the specialisation of the traffic on these two different systems make the need for agreement between them more and more obvious.

Already, for many years, the idea of a division in railway services in the sense of specialisation has become very general, and it seems indeed that this conception has been still further defined in the proposals of different national transport committees.

This solution is a very realistic one taking into account in the first place existing railways and their equipment from which a sane economy demands the best possible output by readapting them to the requirements of new services, speedy, frequent, comfortable, well co-ordinated with other railways, in a word adequate for the needs of their clients.

Over and above this there are the successful experiments made by great railways as well as local railway in the way of modernisation.

Every one has heard of the very encouraging experiments made en 1931 by the Est Railway with a rail motor coach equipped with pneumatic tyres and arranged to operate in either direction. The « Micheline » with which the adherence to the rail of the pneumatic tyre is three times as great as that of a wheel with metal tyres, has a 20-H.P. motor driving two axles. This vehicle which weighs 4 370 kgr. (9 630 lb.) and

which can convey a useful load of 2 160 kgr. (4 760 lb.) can easily exceed a speed of 90 km. (56 miles) an hour. It is intended to carry 24 passengers with hand luggage.

The « Pauline » built by the Midi Railway Company is just as noteworthy. Worked by a gas-oil motor of 75 H.P., it has a dead weight of 6.5 tons with 2 tons of gas-oil and weighs 12 tons when loaded. It is fitted with steel tyres and has covered 100 km. (62 miles) in 1 hour 45 minutes with 22 stops, at the same time showing a considerable saving in comparison with the use of steam as motive power. The « Pauline » seats 61 passengers and takes 1 000 kgr. (2 200 lb.) of baggage, or instead provides standing room for 20 passengers.

If the attempts made by the great railway companies to adapt motor rail coaches to certain light traffics have been numerous, the local railways despite their more restricted financial resources are still very interested in the question. The need for effecting urgent economies at the same time as giving satisfaction to clients easily won by novelties would force them to act in this way even if their experiments themselves had not been extremely encouraging.

I shall take leave, owing to the lack of any more precise information, to quote the case of the Belgian National Light Railway Company.

Profiting by the favourable experience they had had since 1924 with small rail coaches on the Marbehan-Florenville-Ste-Cécile line, the Company decided to try a fresh application. This we will briefly described.

The five steam trains which up to then had sufficed for the daily traffic of the Namur-Huy line lost more than half their clients through the competition of a parasitic motor bus. On 15 January 1931, three motor rail coaches were substituted for the steam trains. After six months working the expense per motor rail coach-mile was reduced to about half that per steam train-mile; the commercial speed was increased from 18 to 35 km. (11.2 to 21.7 miles) an hour, the frequency of the service was nearly trebled, while receipts were increased by a hundred per cent.

Without doubt it would not always be possible to get such results, but at the same time the solutions offered to secondary railway companies are multiplying.

For example — we must be excused for citing another example from our own country — the Belgian National Light Railway Company has just built in its shops a motor rail coach the cost of which will be approximately a hundred thousand Belgian francs, i.e. less than 14 000-gold francs. It has studied the possibility of building a motor rail coach using the body and frame of an ordinary passenger coach.

We will now give a brief description of the vehicle, which contains 24 seats and 16 standing places.

The photographs, figures 2, 3 and 4, give a view of the steam-drawn carriage which was transformed, a view of the side of a train composed of motor rail coach and trailer, as well as a view of the interior of the transformed carriage. As the body is symmetrical and the motor comes almost completely within the sole bars, any sort of carriage of the tram type desired can be adapted. The line, general aspect and all the constructional details of the body can be modified.

The sketch, figure 5, shows a section of the chassis with the motor and transmission.

The altered vehicle is a passenger carriage with the wheel base increased from 2.40 m. to 3.70 m. (7 ft. 10 1/2 in. to 12 ft. 1 1/2 in.). The motor carried between the sole bars is overhung, and drives through conical helicoidal gears in a gear box, an intermediate shaft parallel with the axles carried on the frame in ball bearings.

Fig. 2. — Two coaches of this type, formerly used for the steam-drawn trains of the Belgian National Light Railway Company, were employed in the construction of the train shown in figure 3, made up of a motor coach and a trailer.

Fig. 3. — Motor coach and trailer, Belgian National Light Railway Company.

This shaft drives both axles by means of Renold silent chains in oil bath chain cases.

The whole weight of this carriage is available for adhesion and a trailer of its own capacity can be hauled by it.

The carriage is driven from each end in either direction. The double control of the accelerator, the clutch and change speed gear is assured by steel rods and cables in a simple and solid manner.

The braking, very powerful though without shock, is got by the friction of a wide band of ferrodo on a drum fixed to the axle.

The direction of running is changed by turning a small wheel which moves a sliding sleeve with dogs inside the axle casing in such manner as to engage either the right or the left conical gear as desired.

This makes it unnecessary to turn the carriage.

The frame and the transmission are both very simple and their upkeep presents very few complications.

However, in order to make such a vehicle practically possible with the desired success it must be possible to have a motor which can be adapted to the

Fig. 4. — Interior of motor coach, Belgian National Light Railway Company.

chassis while satisfying all the conditions as regards tractive power, price and comfort. For this the motor must be :

— light, because it is overhung at the end of the chassis;

— of small bulk, it must be placed between the sole bars so as not to project above the floor of the vehicle, yet be sufficiently high above the rail;

— powerful and flexible; it must be able to haul at least one trailer and be able to work in top gear over the gradients of the local steam lines which sometimes are as high as 45 mm. per m. (1 in 22);

— silent and vibrationless; placed almost inside a vehicle running on rails and therefore more noisy than a motor on tyres, it must compensate for this handicap of the rail coach by its qualities of silence and flexibility.

The weight of this particular motor rail coach is 8 700 kgr. (19 175 lb.).

During the first trial runs, the rail coach attained a speed of nearly 80 km. (50 miles) an hour, the object being to test the stability of the vehicle and the behaviour of the transmission gear. This speed is practically useless on our lines, where the stops are near together, so we changed the axle gear ratio so as to

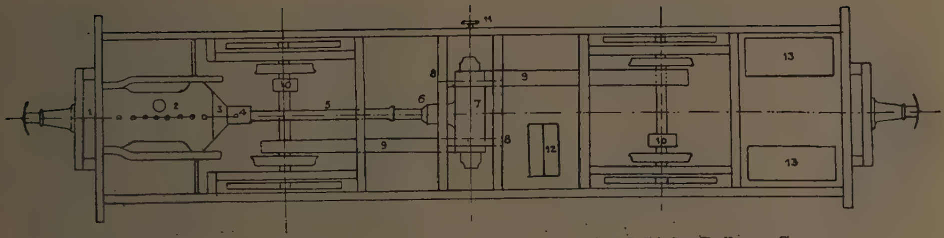


Fig. 5. — Plan view of frame of motor coach, Belgian National Light Railway Company.

1. Radiator.
2. Motor.
3. Clutch.
4. Change speed gear.
5. Cardan shaft.
6. Ball bearings.
7. Axle casing and reversing gear.
8. Ball bearings.
9. Chains and chain cases.
10. Brake drum.
11. Reversing gear lever.
12. Auxiliary radiator.
13. Petrol tanks.

limit the maximum speed to about 60 km. (37.3 miles) per hour, which at the same time increased the tractive power of the vehicle.

We would point out that the motor rail coach is fitted with special elastic wheels of a new type.

The drawings, figures 6 and 7, show in section the two systems of elastic wheels now under test. One of them (Belgian design) has as a connection between the rim of double cone shape and the discs forming the wheel centre 80 indiarubber balls of 30 mm. (1 3/16 inches) diameter, lodged in the corresponding hemispheric cavities; the other (German design) has as elastic connection between the I shaped rim and the discs forming the wheel centre three rubber rings tightly gripped between the discs and the rim.

In both cases the tyres are secured in the usual way (shrunk on hot) on the rims. These wheels are less noisy than all-metal wheels, make it easier to take small radius curves, and contribute a lot to damping out vertical and lateral shocks, as well as to diminishing the vibrations. However, this application is not an integral part of the motor rail coach which can perfectly well do without it.

The President of the Traffic Commission of the Belgian Royal Automobile Club, after having noted in the *Bulletin* of that association, the characteristics of our motor rail coach, did not hesitate to add :

In the interest of the passengers *as well as of motorists* we hope that the National Light Railway Company will not delay in experimenting on a large scale with this transformation. This adaptation of the automobile to the rail is being made methodically. It will enable the railway to combat the road services.

As experiments over several months gave conclusively favourable results, more than twenty old railway carriages are now being altered, and some others will be altered later on, as already the construction of 250 vehicles of this type is under consideration.

How many other methods in the years to come, while speeding up the modernisation of the railways that cannot be electrified, will greatly facilitate co-ordination in its best sense !

And this is not all, as at last — it must be underlined — no one any longer thinks of misunderstanding the power of co-ordination represented by that old competitor of the railway, recognised as

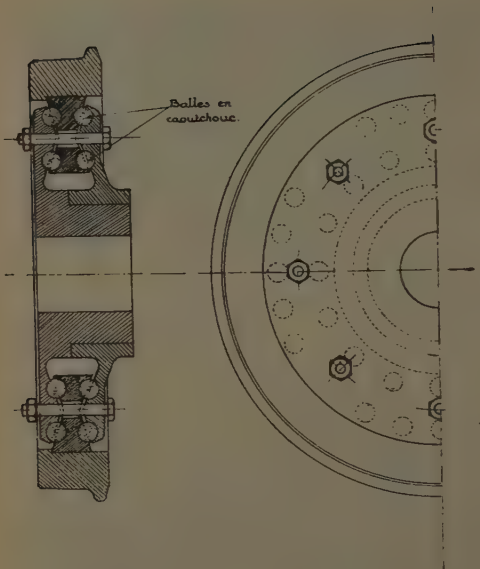


Fig. 6. — Elastic wheel (Belgian patent).

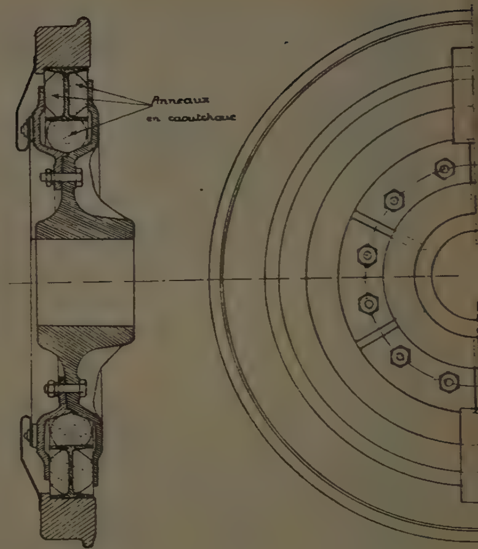


Fig. 7. — Elastic wheel (German patent).

Note: Balles en caoutchouc = Rubber balls. — Anneaux en caoutchouc = Rubber rings.

an adjuvant, and even more often as a valuable ally, we mean the motor bus.

* * *

III. — New methods of transport : new means of co-ordination.

In order to establish in a rational way a system of land communication the intimate connection of railway and road must be foreseen. On the one side there extends the system of the great railways, joined up with the international lines and completed by the secondary railways of standard or narrow gauge, and on the other the road system composed in like manner of main roads joined up with the trunk roads of neighbouring countries, and of second and third class roads joining up with the great arterial roads in such a way as to form closer and closer links.

The collaboration of railway and road, a necessity no longer denied, appears under two distinct forms :

In the first place, the two methods of communication complete each other, by prolonging each other.

In the second place, the railway and the road distribute their equipment so as to establish between given points the most economic transport with the maximum of speed and frequency.

From whatever point of view the question is studied, one is led to conclude that an agreement of the closest kind is necessary between the great and secondary railways.

The different railways can profit by developing the first method of collaboration and providing through transport

in full accord with the light railways and with the minimum of formalities, risk, and bother.

As from 1926 the *Sesa* (Sweizerische Express A. G.) has been constituted on the basis of such principles and has set itself the task of co-ordinating the efforts made to improve goods and passenger traffic.

This company, may we briefly recall, was created by the initiative of the Federal Railways and with the participation of the chief Swiss Railways of both standard and narrow gauge, thus making common cause for the defence of their interests.

In this way they embarked upon entirely new methods. In agreement with the State Inspection Service and the Railway Department of the Confederation, these railway companies decided, as from 1 August 1927, to transport goods of every kind, both slow and express, at the same rates (including the cost of transport from the departure station to the consignee) as those possible for motor services run on an economic basis.

Negociations with the consignors were confided to the *Sesa*.

Thanks to the regulation of responsibility for delays in delivery and of the rates for carting at stations and in localities where *Sesa* agencies are installed, the door-to-door collection and delivery of goods have become as simple a matter as direct transport by motor.

The organisation of a collecting and distributing service in localities where there is no railway was the second step in this co-ordination.

In this way the *Sesa* obtained this remarkable result that in time the parts of Switzerland where there is no railway will be more and more closely connected with the railway and transport by rail will be extended right up to the customer's premises.

Although in a less advanced state, there is the same tendency in France. As from 1928, each of the great railways with the aid of the chief secondary railways, has set up an affiliated auxiliary motor transport company.

The chief object of this company is to develop the feeder services to the railway and to win back to it those transports which it can carry out cheaper than the motor services or under more favourable conditions.

The great railways also have set up organisations to facilitate the grouping and transport of goods from the premises of the consignor to those of the consignee so as to combine the successive use of lorry, railway, and lorry again.

However, the small French railways who do their best to assure by motor services transport between their stations and neighbouring localities work on their own ; present legislation does not yet allow them to organise transports under conditions not provided for in their rating books; they are in consequence thwarted in their efforts and further are isolated and left to their own feeble resources.

On the other hand, many reductions and rates facilities have been made on the great railways in order to limit automobile competition. But up to the present the secondary railways connecting with these railways have not shared in these measures.

In Italy a royal decree of 1929 authorises the State Railways to associate themselves with the numerous other transport companies so as to achieve a collaboration which will safeguard their common interests and those of the public.

An « Institute of National Transports » (I. N. T.) has been set up as a joint stock company.

Its object is to develop commercial traffic as a whole by collaborating with the State Railways by means of new plant or improvements, or as a result of facilities due to the establishment of accessory services and in particular town agencies to collect and deliver goods.

In Germany, the National Railway Company (the Reichsbahn) has in the first place tried to combat motor competition by applying special rates (K rates) lower than the corresponding rates given by motor transport undertakings.

Subsequently it made an agreement with the largest road transport company [the Post Office (Reichspost)] in order to eliminate competitors and to create motor services to act as feeders to the railways.

The Dutch Railways likewise established in 1925 a road transport company the majority of whose stock it controls : the motor lorries collect and carry goods from door to door. In particular they collect together the produce of certain agricultural districts in order to transport these to the stations of the great railways.

In other countries, such as Finland, Spain and Portugal, the railways have contented themselves with making agreements with the concession-holders of motor services so as to establish a feeder traffic for the railway.

In Poland, where the road services are absolutely unrestrained, the railways are asking to be given more liberty in granting rates; they also call for legislation that will regulate the granting of concessions.

Moreover, generally speaking, in every country, the small railways had to suffer from motor competition, without any really effective legal protection, without the effective support of the great railways and even in most cases without sufficient financial assets to enable them to set up auxiliary services or modernise their methods.

We are led to conclude that in most of these cases, in the matter of such transports known as complementary or feeder transports, agreement between great and secondary railways is to all intents and purposes non-existent. Evolution in this direction seems to be in the right direction and certain great railways no longer think they should completely neglect the help that narrow gauge railways, their first feeders, can give them both as defenders of their rights and as developers of new traffic.

The present depression in industry and agriculture has warned the railways. For many of them the time has come to concern themselves with an examination in common of new methods of operation and of adaptation of the costs of transport by rail.

Who cannot see that the great railways, by the direct and indirect advantages given to road transport, are assisting in giving credit to the apparent economic justification of the latter, by facilitating its financial equilibrium. This is an economic mistake even more pernicious than the total neglect of collaboration with the small railways.

It is not possible for us to determine a uniform formula of collaboration for every country. This must of necessity vary from one country to another ; sometimes it would even be possible for several systems to be adopted at one and the same time.

But we are of the opinion that the minimum of what co-ordination between great and secondary railways should be has been set out in the following articles, abstracted from an agreement passed between the Italian State Railways and the I. N. T. Company.

Article 5. — The State Railways will allow the I. N. T. to use free of charge all the operating facilities existing in the stations, such as weighing machines, lifts, loading platforms, yards, depots, etc...

Article 7. — The State Railways and the I. N. T. will adopt those provisions, which, from the point of view of operation, rates, combinations of rates, rapid delivery and commercial conditions in general shall be recognised by common agreement to be of such a nature as will realise more completely the objects for which this present agreement has been drawn up.

Furthermore, this agreement arranges for a reduction in the rates of transport in favour of the I. N. T. for the more important routes. The I. N. T. allows its clients to profit by this, after taking into account its costs and the redemption of the capital invested.

* * *

The second form of co-ordination defined above is very far from being unanimously admitted.

It is understandable that the diversity of interests concerned should be an obstacle to the adoption, in this sphere, of rational solutions.

But the question is such an important one that the public authorities cannot afford to overlook it.

The interests of the whole community are concerned, and this demands that duplication of services shall be avoided, that the total capital invested shall be reduced to a minimum, and the maximum economic results shall be produced by the energies engaged in the transport undertakings.

This is to say that according to what is done in different countries, no bus service should be started until a thorough study has shown that it is really useful to the public and that it will not influence in any harmful way existing transport methods sufficient for the needs of the time. On their side, great and secondary railways, in order to avoid all ruinous competition should, as we have said, make a common study of new measures to be taken to improve their respective services and eventually to establish mixed services by trains and rail coaches or buses.

The rail motor coach, intermediate link between the train and the bus, by adapting itself more easily to variations in the traffic, often makes it possible for secondary lines to increase the rapidity and the frequency of their services while decreasing the expenses.

In certain cases, the bus service, without exactly duplicating the routes of the great and secondary railways, can serve the surrounding district in a different way that is to the advantage of both. In effect, the railway keeps to a well determined route of transport; the distance between the stations and the centres of population increases the time of the journey; connections and crossings make long stops necessary ; on the other hand the meandering lines of the old local railways which reduce gradients and connect up as many villages as possible often have an obvious effect in increasing the time of transport and in this way certain intermediate villages, situated several miles by the railway from each other are comparatively badly served.

Moreover, the omnibus trains establish connections in those districts which apart from the rush hours are expensive to operate and give an inadequate return, while a service by rail motor coaches on these sections would impede the express trains and fast goods trains. Under these circumstances in particular the great railway and the local railway would benefit by an agreement : the first by suppressing the circulation of long rakes of stock would considerably diminish its general expenses and in this way realise a valuable economy in its working expenses, while by the assistance it would bring to the latter, according to modalities to be determined in each case, it could arrange for it to establish a bus service in agreement or in correspondence with its ordinary services. It goes without saying that there can be no question of relinquishing or abandoning any rights and that legitimate interests must be safeguarded. In its turn, the secondary railway could adapt its operation to the new means thus put at its disposal so as to keep the bus in its proper place as adjuvant and feeder to the railways where there is no call for it to exist independently. All this could be done obviously once the principle that the company injured

by loss of clients has a right to damages, is recognised. The public authorities are intended to look after the co-ordination and harmonious development of these different transport methods ; it is for them in the first place to see to it that the new equilibrium is so established that the community shall benefit by a complete transport system, under the control of some authority more competent than the small individual and scattered transport units.

In Belgium a modification of the fundamental statutes of the National Light Railway Company (S.N.C.V.) will enable it to co-ordinate the working of the two kinds of transport by rail and road as complementary or as a substitute to its railway routes.

Up to the present, though limited in its activities by the law, the S. N. C. V. has nevertheless endeavoured to diminish as best it can all competition against its lines by assuring the control of private undertakings : It operates 446 km. (277 miles) of bus routes and 99 bus routes totaling 2 037 km. (1 266 miles) are under its control. It has obtained the authorisation to work a further total of 4 000 km. (2 485 miles); these lines, called « with reduced capital » are, after a concession has been granted, worked by individuals supplying the rolling stock. Unfortunately, up to the present, these services have not fulfilled any function as complement or substitution for the railway.

The disastrous effects of this situation have shown that in Belgium the two methods of passenger transport by rail and by road cannot as a general rule exist side by side and compete with each other without serious effects on the general economy. The operation of regular bus services cannot be uncontrolled; their importance requires that in the public interest they must be co-ordinated with other methods of transport and that competition between such services themselves as well as with the services of great and small railways must by special legislation be kept within limits so that there will be no economic upset.

In France, governmental projects relative to the new organisation of railways foresees in like manner the substitution of trains by motors or by rail motor coaches on main and secondary lines wherever such a measure would result in economies; it also foresees a reduction in the number of trains, the reorganisation of stations, the free allowance of luggage, etc.

Up to the present time the French railway companies have not been authorised to organise commercial transport by road. But a recent decision of the Ministry of Public Works has enabled the Midi Company to carry out by means of a subsidiary company transport of goods by road, not merely the collection of them but door-to-door transport.

For its part, the P.L.M. Company had already organised in different districts a certain number of road services parallel to its lines, to replace suppressed train services.

The same applies to the French State Railways who, on certain routes, have replaced certain passenger trains by buses on the roads.

The « Chemins de fer de grande banlieue » [1.45 m. (4 ft. 9 in.) gauge] have replaced their mixed train services by two distinct kinds of services : one for passengers, the other for goods. The passenger service is first of all assured by steam trains and petrol rail coaches, and has been reinforced by a motor bus service later on.

It is interesting to note that the Ain Departmental Tramway Company is engaged in a lawsuit against a certain motor lorry syndicate which denies it the right to transport goods coming from its railway lines and intended for Lyons which is 22 km. (13.7 miles) away from its terminus. The point of view of this Company can be summed up as follows : « The railways should make people realise that they have a right to assure transports beyond the area of their

concession by motor vehicles as long as they do not fix their rates at values lower than the net cost. »

In Germany since 1929 there has been an agreement between the Reichsbahn and the Reichspost relating to the establishment of intertown motor transport services for both goods and passengers. It should be specially noticed that as far as the passenger traffic is concerned no new services can be set up without the consent of both parties. It is also set down that for such routes established in common by the two companies the profits and losses shall be divided up according to a formula which varies according to whether the service in question is or is not in competition with the railway.

Fifty-one lines, of a development of 1 122 km. (697 miles) were run in common after this method at the end of 1930. This close collaboration has set itself the task of organising these new services under economic conditions and of developing them for the greater good of the public without overlooking the interests of the Reichsbahn itself.

In Italy, road passenger services are subject to a government concession; they are considered by a committee partly composed of representatives of the railways.

Legal statutes forbid all competition. In fact, the traffic to be dealt with between one or several centres connected by a public rail or road service is often so small that it is hardy enough to feed a single service. This makes it necessary for the government to intervene and protect the existing service so that it can continue to exist by being thus protected from all competition from other companies.

In Poland a tax called « The Road Fund » is now levied which affects the motor services as it takes 35 % of the price of tickets and 0.03 zloty per tonne-kilometre.

In Switzerland competition is held within reasonable bounds thanks to the statutes regulating the granting of concessions.

These various notes suffice to throw into relief the diversity of conditions and to show that the policy of the collaboration of parallel services should be more deeply studied and more largely applied.

In any case, it can already be understood that it is of the utmost importance for the existence and the development of the different railway systems that in each country an organisation common to the two railway systems should be set up. It should be required to investigate all problems dealing with the organisation of such transport as will facilitate relations, and also to suppress, in the public interest, pernicious competition.

Furthermore we think we can affirm that no railway manager exists that is not sincerely convinced that the transport crisis we are now suffering from will not be solved by ordinary measures of economy alone, increasing the rates and diminishing the taxes, but above all by the modernisation of the road and rail stock. It is indeed absolutely indispensable for the public authorities to watch over the co-ordination of the methods used and the efforts put forth by the different transport enterprises so that, according to the conclusions of the Road Congress held at Washington: « All transport may be made as far as possible in the most economical way and that which is most appropriate to particular cases. »

* * *

IV. — Administrative relations between railway companies.

It cannot be doubted that if one wished to obtain co-ordination between railways, one cannot too often compare the different points of view that must be conciliated.

Now, close relations or direct, immediate and constant contact between the

great railway companies and the secondary railways cannot be said to be organised in any country. Each railway company depends quite separately on some governmental authority with which it maintains relations well defined by its statutes and set out in the rates books and working regulations. Perhaps it is this closed system which has made the autonomous spirit of each transport enterprise fiercer than it should be, so that it entrenches itself in its own organisation to the detriment of all agreement, though this is more than ever needed.

Transport committees and councils have indeed been set up to remedy this situation by creating a new bond. But all the same more direct contact is quite indispensable. This is obvious from the information we have received.

In Spain, at the Ministry of Public Works, there is a higher council for railways and a general management of the railways and tramways. The technical and administrative divisions of the railway depend upon this latter.

Through these organisations the State controls the Spanish railways, and in a general way regulates the relations between railways, but there is no section exclusively devoted to the co-ordination of transport between the different railway companies.

In Bulgaria, the secondary lines, or the majority of them, are part of the State railway system and have no special management.

In Poland the situation is similar.

In Italy it is the Ministry of Transport which occupies itself with the co-ordination of transports between different railways, as well as with problems concerning the organisation of transports, the study and co-ordination of rates.

In Portugal the general administration of the railways is somewhat similar.

In Greece a higher transport council has lately been set up which can study the question of co-ordination.

In Germany, there is no governmental organisation to assure co-ordination of transports between the State railways and the private railways. In special cases the small railways or their representative, the Federation for the Operation of Railways at Berlin makes suggestions to the great railway, which are regulated by means of negociations. They can also lay rates proposals for goods traffic before the great railways.

In France and Belgium a higher transport council has been established which in independent of the general administration of the railways by the ministry.

In France, the « Direction Générale des chemins de fer » at the Ministry of Public Works, exercises control over the local railways as well as over the great lines ; several offices of this administration are occupied at one and the same time with both classes of railways. Furthermore, railways of purely local interest are represented at the Higher Railway Council which is a consultative organisation which the Ministry of Public Works obliges the railways to consult for all questions in which all the railway companies are interested.

In Belgium since 1930 only the Ministry of Transport can grant concessions or authorisations to railway companies as well as to tramway and bus companies.

Since 1928 a « Higher Transport Council » has been set up. Its object is to examine all questions relative to the co-ordination of the different methods of transport of the Kingdom and to propose to the government such measures as will obtain the best possible output from the whole transport equipment of the country. This council consists of at least thirty-one delegates. The Ministry of Transport has four delegates, but only one of these, in the service of the concession-holding lines, specialises in railway questions.

Furthermore, it is interesting to note that the great railways and the secondary railways are both represented at this council by a single delegate. No

matter how qualified this latter may be, it must be admitted that it is a small proportion out of thirty-one. It is to the labours of this organisation that the secondary railways owe the tabling of a law permitting the S. N. C .V. to set up bus services in order to improve the working conditions of its lines; this law has just been passed.

In the mean time the great railways and the secondary railways had to content themselves with making use of existing laws, and so they have undertaken the improvement of their operating services. A mixed committee has been set up composed of representatives of the two companies and presided over by the Minister of Transports or his representative. The object of this committee is to co-ordinate methods of transport by rail and road and to establish an effective collaboration between the two national companies of railways and light railways.

Many important questions concerning collaboration still await solution.

However certain relatively interesting agreements have been made on the following points :

1. The use of transporter-trucks of standard and narrow gauge ;

2. Restitution delays and hiring rate for stock lent to the secondary railway ;

3. Goods rates.

In Switzerland, all the railways are supervised by the Federal Railway Department.

Between railway undertakings and the Swiss steam boat services there is furthermore besides the « Agreement on the through Swiss services for passengers, baggage, animals and goods » already mentioned a « Commercial Conference of Swiss transport undertakings and traffic interests. »

Its object is : to realise by deliberation and by giving counsel on questions concerning through traffic, uniformity of transport regulations and of the rates prescribed by railway legislation and forming the first condition needed to establish through traffic, and to adapt as far as possible the measures to be taken to the conditions and needs of the economic life of Switzerland.

This conference is composed of :

5 delegates of the Swiss Union of Commerce and 25 industrial delegates, including a delegation of the Swiss Commercial Travellers' Society ;

3 delegates of the Swiss Union of Arts and Crafts ;

5 delegates of the Swiss Peasants' Union;

2 delegates of the Swiss Consumers' Society;

2 delegates of the Union of Swiss towns.

It appears indeed that the activities of the greater number of these institutions and even their spirit are still inspired by the monopoly that the railways have enjoyed in practice up till recent times. Therefore it is not surprising that the conclusions of the last railway congress at Madrid and the road congress at Washington in favour of the coordination of road and rail transport have in general been very tentatively applied.

The great railways and the secondary railways, the main and secondary roads are at the present time ways of communication over land capable of giving much more extended services than those required by any given district.

Therefore, it seems to us that the real problem and the most pressing one is the adaptation of the equipment to the kind and to the importance of the traffic, at the same time giving all necessary attention to the requirements of the national economics.

In any case it is not simply a question of effecting practical co-ordination between transport services, but also of clearly defining beforehand along what lines this co-ordination should be accomplished.

* * *

V. — General remarks.

After having tried to set forth the economic principles which underlie all co-ordination in the transport sphere, and after having set ourselves the task of showing what in our opinion could be realised in the operation of railways, whether principal or secondary, it now remains for us to conclude this study by concentrating in a few lines all that we wished to be done in the present report.

We are pleased to recognise that the conclusions we will submit for discussion is the same in spirit as those adopted by the great railway and road congresses of the last few years.

The road congress at Washington, in November 1930, adopted conclusions in which the following declarations were contained :

The problem of the co-relation and the coordination between railway and road requires, more or less urgently, a solution based on economic and scientific principles; the object of these being that the public taken as a whole should profit to the maximum degree by all the facilities these different methods of transport can offer it...

If one considers the different proposals made in order to achieve better co-ordination of transport by rail and road, they all lead back to one or more of the three following systems :

a) Volontary co-operation between railway companies on the one hand and the owners of bus services or public road goods services on the other;

b) The creation of transport services on the roads by railway companies or their financial and administrative control of these, or again their participation in road transport undertakings;

c) Co-ordination (to be determined by law) which would carry with it the obligation for all the different transport companies of adhering to the establishment of a system of co-operative operation and, in cases where such an adherence cannot be obtained, co-ordination enforced by governmental authority.

Several months later, in May 1931, the resolutions voted by the International Chamber of Commerce at a meeting held at Washington, were inspired by the same necessities and recognised the same principles :

Taking into consideration the conclusions of the International Railway Congress held at Madrid in 1930, on the subject of competition between motor services and railways, and the resolutions of the International Road Congress at Washington with which they entirely agreed, i.e. that in future the question of co-ordination and harmonisation between different methods of transport should be the object of reports prepared in common by mixed committees, *composed of the authorised representatives of these different means of transport;*

Taking into consideration the fact that competition between motor services and the railway often has a serious effect on the economic situation of all countries and gives rise to vast problems on the relations between all methods of transport, and as a result to grave problems of political economy over and above the purely technical aspect of co-ordination between rail and road;

It would seem that in spite of the different aspect of the problem in different countries, it has become necessary to study it from a general and international point of view, proceeding with caution to an exhaustive examination of the necessary revision of all the methods of transport affected by the rapid development of motor transport;

Obviously in the end the traffic will go to the most efficacious and cheapest method of transport;

It must be stressed that it is impossible to separate the study of the relations between railways and motor services from the revision of the entire system of transports, made necessary by technical progress...

Without doubt, we do not mean to go quite as far as the Road Congress at Washington nor to point out among

the possible systems co-ordination by legal restraint; but all the same it is true that the principles which we have just cited are no less valuable for co-ordination between great and secondary railways than for the co-ordination of rail and road.

We would even ask if it would be logical to co-ordinate the great and secondary railways between themselves after rail and road had been co-ordinated, and if, on the contrary, it is not necessary that the co-ordination of the railways themselves should precede this latter, or at least be achieved at the same time, especially as in many cases the motor service itself would be one of the chief elements in such co-ordination.

Without wishing to deny that there are railways and even whole countries in which the principles we have enunciated are applied or are about to be, it is impossible to overlook the fact that in the greater number of countries, much if not everything still remains to be done in order to co-ordinate the great and secondary railways.

Doubtless, the negociations that have to be made in order to realise the practical co-ordination we have outlined can be both a long and delicate matter, but their whole success will depend right from the beginning on the spirit in which they will be made, and on the principles on which they are based.

No one would deny that very considerable progress will have been made the day that the railway administrations, primary and secondary, shall have arrived at an agreement, not only on the necessity for co-ordination, but still further on the idea of solidarity, interdependence and common interest on which all co-ordination must be based if it is to be truly realised.

SUMMARY.

We have therefore the honour of submitting the following summary to the Congress for approval :

1. The essential principle which must underlie all co-ordination, but in particular that between great and secondary railways, is none other than the public interest, i. e. in the first place the most general economics must be safeguarded.

2. The interests of the railways should coincide with the general interest of the people : this is the chief criterion of all sane railway co-ordination.

3. The public railway services — which form an important part of the national patrimony and fulfil an economic and social role by which the whole community, especially in an indirect manner, benefits — have the right to be protected against all that might ruin their activities, on condition that they concentrate on their own development and adapt themselves to the requirements of the traffic.

4. It is for the central authorities to see to it that the policy of transport is such that nothing can be undertaken likely to have an adverse effect on the national economics.

It is therefore their duty to prevent whatever might impede the modernisation and the co-ordination of the railways, primary and secondary, and especially duplication of services that cannot be economically justified and competition that gives rise to no particular good, but on the contrary is harmful to the general interest.

Likewise it also behoves Governments to see to it that such co-ordination is realised and to do everything they can in order that it shall be realised in a spirit of progress beneficial to the whole country.

Brussels, 27 January 1932.

[656. 254]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

XIIth SESSION (CAIRO, 1933).

QUESTION IX :

Automatic train control and train stop. Track equipment. Locomotive fittings. Methods used for repeating signals on the locomotives. Devices intended to ensure the attention of the drivers [1].

REPORT No. 1

(All countries except America, Great Britain, Dominions and Colonies, China, Japan, Belgium, Spain, France, Italy, Netherlands, Portugal and their Colonies, Denmark, Finland, Luxemburg, Norway and Sweden),

by W. STÄCKEL,

Reichsbahndirektor, Mitglied der Hauptverwaltung, Deutsche Reichsbahn-Gesellschaft (German State Railway Company).

GERMAN NATIONAL RAILWAYS.

I. — Design and application of automatic train control.

The three methods of train control, hereafter described, are in use on the German National Railway Company.

a) *Mechanical train stop,* which has been installed on the Berlin and Hamburg city and suburban lines. A total of 323 km. (201 miles) and 1 548 motor vehicles with driver's compartment on electrically operated trains and 22 steam locomotives have been equipped. This equipment has been in service since 1928;

b) *Electro-inductive train control* (« Indusilor »), which is in operation on 1 152 km. (726 miles) of line carrying express trains, and on 125 locomotives;

c) *Optical train control,* which is in operation on 191 km. (119 miles) and is fitted to 4 locomotives.

While the installations described under *a*) may be considered as fully developed, that under *b*) is in the nature of a large scale experiment, the cost of which is borne by the National Railway Company. Most of the locomotives equipped with the « Indusilor » have, however, been used for a number of years in regular service, so that their behaviour in continuous working can be judged.

II. — Object of train control.

Up to date, train control has been developed on the German National Railways, from the point of view that it provided an *additional* aid to safety. The guarantee for safe working must, in principle, be the *watchfulness of the driver.*

The reasons for making the installations are follows :

1. The duty of the locomotive driver is not only to keep a watch for signals,

[1] Translated from the German.

but it is also of importance that he should be on the look out for unforeseen occurrences on the road. Even if train control apparatus had been so perfected that observation of signals were superfluous, it would still be necessary, in view of accidents, such as the blocking of an adjacent track, to keep a continual look out. The watch on road conditions could, however, in consequence of the rarity of unusual happenings, easily become slack, if it were not for the necessity for continualy looking out for signals. It would therefore appear dangerous to instal train control in such a manner that the looking out for signals became unnecessary.

2. It is exceedingly difficult and indeed almost impossible to construct a mechanical installation, which is subject to the rough conditions of locomotive operation and which also depends on the satisfactory working of numerous other apparatus in the track, in such a way that occasional failures are impossible.

3. As steel sleepers are in use on many sections of the National Railways, « point control » is necessary. The difficulties in the way of installing a satisfactory track circuit are still greater where steel sleepers are in use. In the case of the « point system » it has to be kept in mind that a failure of a part of the track system may occur, unknown to the driver.

4. It is especially necessary, in the case of the « point system », to arrange the control so that it does not encourage the driver to relax his vigilance as regards the signals. If this can be assured, and if at the same time, the design of the train control is such, that while failures are, if not impossible, but very rare, safety is almost doubled, and whereas formerly accidents have occurred through failure on the part of the driver, the train control will in future intervene to prevent them. If the required conditions are fulfilled, the chance of a failure of the driver simultaneously with the failure of the control apparatus may be considered as extremely unlikely.

In designing the methods of train control in use on the German National Railways it has been regarded as of utmost importance that the driver should not be relieved of his duty of keeping a look out for signals.

In these circumstances it is necessary that the signals should be retained in their entirety, even where train control is installed.

The question of suppressing the fogging services when installing train control, does not concern the German National Railways because fogging service has with few exceptions been rendered unnecessary by the development of advance signals and the provision of signal position indicators (Baken).

III. — Operation and design of the various systems.

1. Mechanical stops on the Berlin city and suburban lines.
(Siemens-Schuckert design).

A. *Operation.* — Train control operates only at predetermined points on the sections (point system) and these are at the home signals.

The control operates by the application of the train air brake and, in the case of electric motor vehicles, by cutting off the driving current, while in the case of steam locomotives steam is not shut off. The stops operate when a home signal in the danger position is overrun. The apparatus does not operate when the home signal is off.

As, in the case of the city and suburban lines, the distance required for braking does not generally exceed 300 m. (1 000 feet) it was permissible to set the home signal back from the danger or fouling point by the amount of the braking length. As a result, the control ensures the train coming to a stand at the danger point at the latest.

The maintenance of the drivers' vigilance is ensured (see chapter II), when the stop is fitted, by two circumstances :

1. In the case of the proper observance of the stop signal, the control does not operate; it does not, therefore, give the driver any assistance in the observation of the signal.

2. In the case of inadvertent overrunning of a home signal in the *on* position, the occurrence is recorded by a mechanism, the so-called « danger recorder ».

3. Releasing the brakes and restarting the train after the control has acted, causes an appreciable delay. When the brake is brought into operation by the control, the brake pipe can only be recharged after it has been completely exhausted (see B).

A special attachment, also provided with a recorder, known as the « Ad.-Zähler », allows a home signal to be passed when such signal is out of order and cannot be set to « line clear ». This attachment prevents the control becoming operative. It cannot, however, neutralize the effect of a control which is already in operation. It is thus impossible to use it to cover up the accidental overrunning of a stop signal. The duration of the permissive operation of the device is so arranged that it is again in operation at the next home signal. This limitation, moreover, is opposed to a so to say anticipated use of the device.

Finally an additional sealed cut-out is provided by means of which the train control can be put out of use for lengthened periods, in the event of any parts being damaged.

The train control is tested before each trip.

B. *Description.* — Operation is effected mechanically by the movement of a lever, projecting horizontally from the motor vehicle, which engages with a contact bar. The actuating lever consists of a very flexible laminated spring assembly with a cylindrical end (figs. 1 and 2), which engages with a contact bar consisting of a ramp-shaped rail 1.50 m. (4 ft. 11 in.) long and 120 mm. (4 3/4 inches) broad which is fastened to the right hand rail at the home signal, at a height of 56 cm. (22 inches) above rail level. (fig. 3). The inclination of the ramp is 1 in 13. When the signal is *on* the lever on the vehicle engages with the contact bar. When the position of the signal is changed, the contact bar is moved so that it is clear and the lever on the vehicle, in the *line clear* position, can pass without making contact (figs. 2 and 4). Where daylight signals are in use, the movement of the bar is carried out by means of special electrical gear, while in the case of « form » signals the bar is generally operated by rod connections. These connections are so arranged that the resistance to movement of the contact bar has no prejudicial influence on the movements of the signal itself.

The overlap of the transmission parts amounts to 53 mm. (2 3/32 inches). The lever projects 93 mm. (3 21/32 inches) beyond the vehicle gauge and in the worst position of the vehicle projects 18 mm. (11/16 inches) beyond the construction gauge.

This gear requires no consumption of electric current when working.

The transmission gear is directly operated as shown in figure 2, by the rotating movement of the control lever on the vehicle from its rest position. In order to convert this movement into one applying the brake and cutting off the driving current, the operations shown in figure 5 take place.

The turning of the lever opens a two-chamber (release) valve which exhausts both the train pipe and one of its branches which operates a driving current cut-off switch. The exhausting of the train pipe operates the train brakes. The ex-

hausting of the switch valve chamber, which may be seen on the left in figure 5 closes the switch under the influence of the excess pressure in the main chamber of the switch valve. The stopping and restarting of the train is carried through as follows :

Although the lever, after passing the contact bar, has been returned to the normal position, vertical to the axis

Fig. 1.

of the track, by the action of a check spring, the release valve is still held in the open position by the excess pressure of the air passing through the main chamber. The spring in the small chamber closes the release valve only when the brake pipe has been fully exhausted and the train thus brought to a stand.

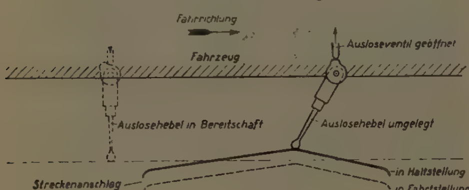


Fig. 2.

Explanation of German terms :

Auslösehebel in Bereitschaft = Actuating lever in the ready position. — Auslösehebel umgelegt = Actuating lever reversed. — Auslöseventil geöffnet = Release valve opened. — Fahrrichtung = Direction of running. — Fahrzeug = Vehicle. — In Fahrtstellung = « Line clear ». — In Haltstellung = At « danger ». — Streckenanschlag = Track pedal.

Fig. 3.

Only then can the driver recharge the brake pipe, thus bringing the swich into the running position by the operation of a resetting flap valve and, providing no obstacle exists, the train can then be again got under way. The non return valve forms an important item in the apparatus; it prevents any loss of air from the pipes connected with the train control and therefore prevents the switch from operating in normal braking, which is

quite independant from the train control. The non return valve opens only under excess pressure in the main train pipe, when the automatic train control comes into operation.

The selection of the mechanical type of train control for the city and suburban lines was made as a result of years of experience on account of the suitability of location of the contact devices on the vehicle and in the track. In the early examples of the design here described, the gear was partly placed level with the roof of the vehicle where heavy side oscillations had to be dealt with, while, where the gear was placed close to the road, with a release lever hanging vertically from the vehicle, heaped-up ballast and accumulations of snow often operated the control out of course. The

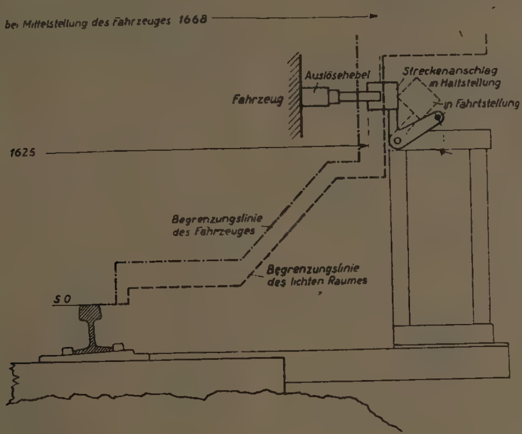


Fig. 4.

Explanation of German terms:
Begrenzungslinie des Fahrzeuges = Construction gauge of vehicle. — Begrenzungslinie des lichten Raumes = Maximum moving dimensions. (*See also fig. 2.*)

placing of the lever in a horizontal position at a height of 56 cm. (22 inches) above rail level, as above described, has the great advantage that the gear safely clears all drifting snow and such like accumulations, while, in addition, the oscillation of the vehicles at that level does not give rise to any perturbating effects.

The mechanical train stop used at Hamburg differs on some points from the Berlin design, but is basically the same and a special description is therefore necessary.

The good results obtained with the mechanical stop in heavy suburban traffic have naturally led to frequent and thorough discussion as to the possibility of extending the application of this simple type of train control to the whole National Railway system and especially to lines carrying high-speed traffic, as test results show that breakages of the highly elastic levers mounted on the mo-

tor vehicles do not occur, even at high speeds. In connection with this question, the differences in the braking distance on the various railway systems must be taken into consideration. It has already been shown that the braking dis-

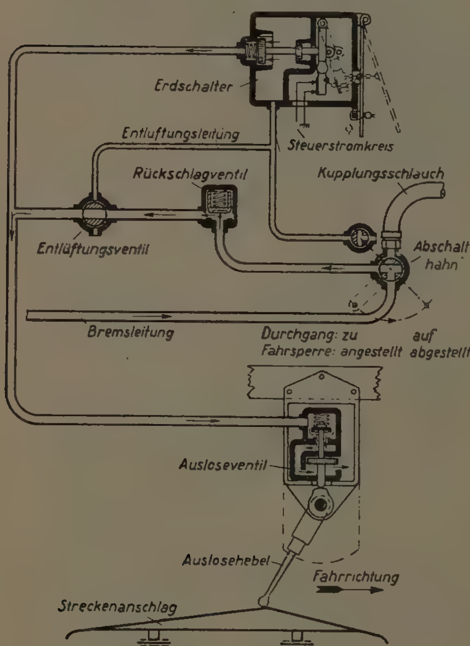


Fig. 5.

Explanation of German terms:

Ausschalthahn = Cut-out cock. — Bremsleitung = Brake pipe. — Durchgang zu (auf) = Passage closed (open). — Entluftungsleitung = Exhaust pipe. — Entluftungsventil = Exhaust valve. — Erdschalter = Earthing switch. — Fahrsperre angestellt (abgestellt) = Automatic stop on (off). — Kupplungsschlauch = Coupling hose. — Ruckschlagventil = Non return valve. — Steuerstromkreis = Control circuit.

tance in dense suburban traffic is only 300 m. (1 000 feet) and that in these circumstances a clear length with regulator shut or driving current cut off, representing the total braking distance can be provided inside the home signal. In the case of the other main lines of the National Railways, a braking distance of 700 m. (2 300 feet) is necessary, while in the case of certain lines with fast-running trains even 1 000 to 1 200 m. (3 300 to 3 950 feet) must be allowed for.

It is not possible to set back the home signals to such a great distance from the danger point, on account of the high cost entailed and the unsatisfactory results obtained in working. In these circumstances there can be no question of placing the control on express train sections, at the home signal. The control point must for preference be located at the distant (advance) signal or at least at an appreciable distance in front of the home signal. In the case of a mechanical stop, the operation of the contact bar at such a distant control point, would entail considerable expense for cable and electric operating gear because the mechanical coupling to the distant signal and its connections would be impracticable on account of excessive load. Further the mechanical stop, in its present form, does not permit of its being connected to both the home and the distant signals. There are also difficulties in connection with clearances, which have hitherto prevented the installation of the mechanical stop on lines other than those of the Berlin and Hamburg suburban systems. Its application is therefore confined at present to lines where it is possible to fix the automatic control point at the home signal and where the clearance conditions are suitable. It is certainly noteworthy that efforts are being made at the moment to make the mechanical type of stop suitable for lines carrying express traffic. It is however not as yet possible to forecast the result.

Single line working is not an obstacle to the installation of the mechanical stop system.

2. Inductive train control (Indusilor).

A. *Method of operation.* — This type of train control is, by comparison with that described above, very much more suitable for use on the express traffic lines of the German National Railway system. In this system also, trains are controlled only at certain points on each section and it is, therefore, also a « point » system.

The transmission of power from the track to the locomotive is effected by the Indusilor without any mechanical contact, by the action an of alternating magnetic field, excited by electromagnets on the engine. The transmitting mechanism on the track consists of coils with iron core and condenser, so called track magnets, which set up a resonance on the alternating field on the engine.

An arrangement of relays and valves, the « operating mechanism » is carried on the locomotive, by means of which the magnetic flux is transformed into mechanical work (application of the brakes, etc.).

As a basis for the description of the operation of the latest type of *Indusilor*, a short precis of the developments to date, is given below.

On express traffic lines, it was not found possible as was the case with the stop mechanism described in section 1, to

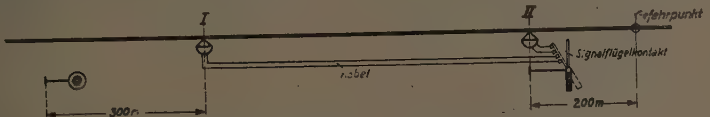


Fig. 6. — Inductive train control. Arrangement of track electromagnets for one frequency.

Explanation of German terms:
Gefahrpunkt = Danger point. — Kabel = Cable. — Signalflügelkontakt = Blade-shaped signal contact.

place the home signal at the necessary braking distance from the danger point, i. e. 700 m. (2 300 feet).

This led to the stop being placed at the distant signal instead of at the home.

In the earlier installations, the objects aimed at were confined within very narrow limits. A control placed 200 m. (650 feet) in front of the distant signal, and not dependent on the position of the signals, was considered sufficient. Under this system the application of the brake was not brought about and an acoustic signal in the locomotive cab was considered sufficient. This system had, on the one hand, the disadvantage that it attracted the attention of the driver before each distant signal and, to a certain extent, tended to encourage him to neglect observation of the road, while on the other hand it did not in any way prevent accidents. The only end it served well was that it assisted the driver to pick up signals in conditions of bad visibility. This object was later attained by the warning boards, which unlike the cab signals have no paralysing effect on the watchfulness of the driver, but rather stimulate it.

Such considerations and experiences led to a complete change in the arrangements for automatic train control (fig. 6).

1. The control point was removed in front of the distant signal, so that the driver might be able, in the interval between the distant signal and the control point, to advertize his alertness by using the « acknowledging » or « alert » key.

2. The control also, only came into operation when the home signal was at danger; in the *clear* position the track magnets did not come into operation. This arrangement made it possible to confine the driver's duties to the use of the alert key if the signal was at danger,

or, if he did not use it, i. e. in case of danger, to the application of the air brake. Apparatus for shutting off power was not considered.

The *Indusilor* provided an astonishingly simple solution to the problem of suspending the operation of the section (track) magnets when the home signal was off. The provision of a cable connection between the section magnet and a circuit closer on the home signal sufficed. Further information on this subject will be found under B).

As an analysis of certain serious accidents had shown that it was necessary to provide for a mistake by a driver as to the position of the home signal after proper reading of the position of the distant signal, especially where groups of signals were concerned, the section installations were extended by the provision of a second section magnet at the home signal. (Automatic control point II in fig. 6.)

It was not considered desirable, however, to increase the clearance before the home signal beyond 200 m. (650 feet); consequently an accident could only be prevented by the main signal magnet, if the train as a result of the warning at the distant signal, approached the main signal at a maximum speed of 70 km. (43.5 miles) per hour. As it was considered that this could not be reckoned on with certainty, a further appliance was provided which was known as the « speed control attachment ».

This was brought into operation when the above mentioned alert key was used and consisted of a mechanism in the nature of a distance recorder, driven off the locomotive axle, which after a distance of 300 m. (1 100 feet) had been travelled, brought about an application of the brake, if in the meantime the running speed had not been reduced below 70 km. (43 miles) per hour. The description, « speed control attachment » was intended to indicate that the application was not brought about by a special control from the track but by the use of the alert key, in contra-distinction to the « automatic speed control » mentioned hereafter. The working of this old-pattern control (1925-1929) was as follows (see fig. 6) :

1. When the home signal was *off* nothing occurred on the train; no work had to be done by the driver.

2. When the home signal was *on*, application of the brake at automatic control point I, 300 m. (1 100 feet) behind the distant signal. If the alarm key had not been used between the distant signal and point I, the train was brought to a stand at the latest, 200 m. (650 feet) behind the some signal that is to say still short of the danger point.

3. When the home signal is in the *on* position and the alert key has been used at the correct time between the distant signal and control point I, the brake is not applied. If the alert key is operated *before reaching* the distant signal, application of the brake cannot be prevented. Indeed, the alert key is only operative as a provision against the train control until the speed controller, mentioned previously had run down, that is to say over the distance of 300 m. (1 100 feet).

4. In the event of a longer run, without the speed being reduced below 70 km. (43.5 miles) per hour, application of the brake would take place at a point 300 m. (1 100 feet) beyond where the alert key was pressed. Such brake application also takes place even if the home signal is lowered in the interval. The braking distance to the danger point will be about 450 m. (1 475 feet).

5. If the speed of the train is reduced below 70 km. per hour at the proper time, no braking then takes place.

6. On overrunning the home signal in the *on* position, in spite of speed being

reduced, the brake will be applied at control point II. The braking distance to the danger point was 200 m. (650 feet).

7. In the event of the home signal being *on*, but in the absence of the mistakes mentioned under 4) and 6), the brake is not automatically applied. The driver has freedom to brake as he desires.

Under these earlier conditions, the following disadvantages existed :

1. The cable connections between automatic control point I and the home signal increased the cost of installation undesirably.

2. It was found that the speed control was troublesome, in that speed limitation persisted even if, shortly after pressing the alarm key, the signal was pulled *off*.

3. With the great distances (up to 1 500 m. = 4 900 feet) which are common at German stations, between the advanced starting signals, placed at the sites of the incoming signals, and the outgoing main signals, the speed controller came into operation appreciably earlier than was necessary to ensure a properly timed stop. The danger also arose that after the speed had been controlled, it might again be appreciably increased.

Fig. 7. — Inductive train control. Arrangement of track electromagnets for 3 frequencies.

Placing the automatic control point closer to the main (home) signal where advanced signals were very far out, was not compatible with the use of the above mentioned appliance (speed controller depending on distance run) combined with the alert key, because they necessitated that control point I should be placed at least 300 m. (1 100 feet) behind the advanced signal.

The latest general arrangement of *Indusilor* train control has therefore been worked out on the following plan (see fig. 7) :

1. An automatic point V is placed at the site of the distant signal and, when this signal is in the *warning* position, it actuates a 7 seconds time relay. Should the driver not have pressed his alert key before this time has elapsed, the brake is applied. If, on the other hand, the key is pressed at the proper moment, the brake is not put into operation, but a record is made (1).

2. When the home signal is at danger, the brake comes into action at a control point G which lies 250 m. (820 feet) in front of the home signal, if the speed of the train at the moment of control is more than 70 km. (43.5 miles) per hour (independent speed control).

3. If the train overruns the home signal at danger, the brake is at once applied at control point H which is placed at the home signal.

In order to put the track magnets V out of action as soon as the distant signal is pulled *off*, the signal is fitted with a disc contact connected to the magnets. The track magnets G and H are in the

(1) Should the *Indusilor* come into use for goods trains, it will be necessary to have an acoustic signal to come into action after the time meter runs down and only if this warning is disregarded will the brake come into action. This arrangement would also warn the brakesman of the brake-fitted wagons at the tail end of the train.

same way connected to a knife contact on the home signal. On account of the cost, G magnets will only be installed where it is considered possible that on account of special circumstances, there is danger that a driver may mistake the position of the home signal after having correctly observed the position of the distant signal. Generally magnets V and H will suffice.

As has been explained, the working of the controls at points V, G and H, differs. On this account the track magnets at the three points cannot all be of a similar nature. The necessary differences are obtained by the use of different alternating current frequencies for the transmission between the track and the locomotive (this subject is further dealt with under B). This latest form of *Indusilor* is therefore designated the « three-frequency system ».

It will be understood readily enough that the defects that existed in the old single frequency system have been remedied. The amount of wiring required is small, since control point G can, in the majority of cases, be dispensed with, while points V and H only necessitate a few yards of cable. The speed limitation at point G is eliminated with the signal change, it does not occur before it is required, since the distance between point G and the home signal can be fixed independently of the distance to the distant signal.

The three-frequency system is used on sections having distant signals giving three indications, to compel running at reduced speeds, when the home signal indicates the necessity for slow running. The distant signal magnet V in such a case operates as if the home signal were at danger ; the driver must therefore use the alert key. Where a G magnet is installed, this also comes into operation and compels a reduction of speed to less than 70 km. per hour, while the home signal magnet is so connected that it does not excercise control.

This arrangement can also be used for sections which have to be run over temporarily at reduced speed. A section magnet of the V type is placed at the slow (caution) signal which, on the German Railways is now fixed 700 m. (2 300 feet) in front of the commencement of the slack ; so long as the slack is in operation the magnet is maintained in operation and the driver must use the alert key.

The following description shows how the important matter of the driver's vigilance is assured by the arrangement of the three-frequency system.

1. No control takes place *in front* of the distant signal ; the driver therefore, is not absolved of his responsability for the observation of that signal.

2. The automatic control at the distant signal is not immediately perceptible to the driver.

3. Should the driver permit an application of the brake by the automatic control, the fact will be recorded.

4. Anticipated operation of the alert key is ineffective; a lengthy depression of the key is prevented by special apparatus (see B).

5. The train will be brought to a stand should the brake be applied by the control, even if in the meantime a free road is given.

The release apparatus, which closes the brake release cock after a compulsory application of the brake by the control, was at first fitted outside the engine. In view however of the possible danger to the staff at certain points, the apparatus was moved into the cab but special means were adopted (see B) so that the train came first to a standstill.

The determination of the length to be run with regulator shut (or with current cut off) behind the home signal is closely connected with the question of vigilance. In considering this question, one must start from automatic control pont V. If

the whole of the apparatus were so designed that the key must be pressed *before* arrival at the distant signal, it is possible, in the event of inattention, to let compulsory application of the brake take place directly at the distant signal, and the whole distance up to the home signal is then available for braking. Hitherto, however, such an arrangement has been mistrusted, because it was feared that in case of fog or very poor visibility, the key might be operated too soon and before the distant signal had actually been sighted. The alert key must only be used when the distant signal has actually been seen.

As, on these grounds, the control was arranged to operate the brake before arriving at the distant signal, it was necessary, either to increase the interval between the distant signal and the home signal or to give more space between the home signal and the danger point, if trains running at the highest speeds were to be brought to a stand clear of the danger point. The second of these alternatives was decided on, because an increase in the space also provided longer braking distances for the G and H controls and steps were therefore taken in the case of home signals, to increase the distance between the home signals and the danger point to 200 m. (650 feet). The signal re-siting necessary for this could, on most sections, be kept within reasonable bounds. There was no question of moving the starting signals at stations, as the German safety installations generally include interlockings which ensure ample distances behind the starting signals; removal of block signals is only necessary in rare instances, because in most cases considerable distances exist up to the danger points.

When passing a defective signal in accordance with the regulations, a normally lead-sealed key in the cab has, as a rule, to be brought into operation. Use of this key cuts out the H control at the home signal; on the other hand, it does not make possible to suspend the V and G controls. If this key is held in longer than is necessary, a compulsory brake application follows.

The operation of the train control apparatus by the driver (as for instance use of the alert key) and the corresponding working of the train control, are recorded on a roll on which the speed curve is also recorded.

1. When the train control is in operation, a continuous line is drawn in the center of the roll.

2. When the control applies the brake, the application is recorded by a short line.

3. The operation of the distant signal control and the use of the alarm key are also recorded.

The driver can cut out the whole apparatus on the locomotive, in case of damage, and this action suspends the record so that intervention of the driver is always known.

The working condition of the control is tested before the commencement of each trip after the turbine has been started up, by switching on the apparatus and conducting a compulsory braking test. Track magnets are installed in the outgoing engine roads of the sheds concerned and these are permanently energized. On passing these magnets all phases of operation (V, G and H), are tested.

As in the case of the intermittent system, there is some danger that the failure of a track control may remain undetected, the track magnets are tested at regular intervals by an inspector by means of a portable testing apparatus.

B. — *Technical details of construction.* — The basic idea of the transmission from the track to the locomotive as carried out with the Indusilor has been explained under A. According to this, in

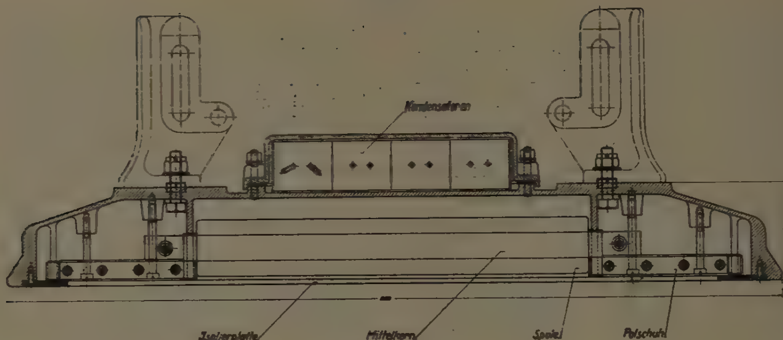


Fig. 8. — Inductive train control. Electromagnet on the vehicle.

Explanation of German terms:
Isolierplatte = Insulating plate. — Kondensatoren = Condensers. — Mittelkern = Central core. — Polschuh = Pole piece. — Spule = Coil.

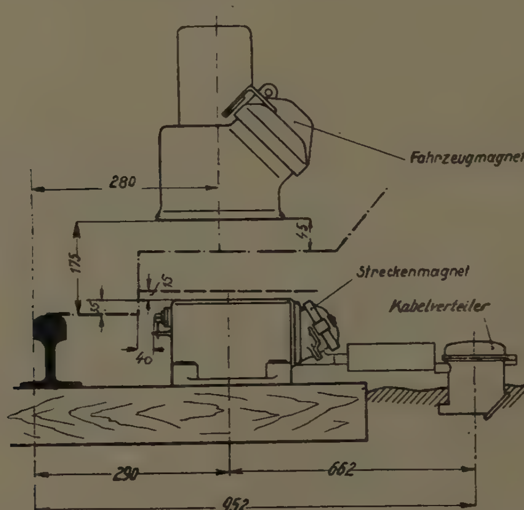


Fig. 9. — Inductive train control. Arrangement of electromagnet on the vehicle and of that in the track.

Explanation of German terms:
Fahrzeugmagnet = Electromagnet on the vehicle. — Kabelverteiler = Cable distribution box. Streckenmagnet = Track electromagnet

order to operate on the train it is necessary to produce an alternating magnetic field on the locomotive. The necessary current for this purpose is supplied by a turbo-generator which is in any case provided for lighting the locomotive and

which supplies a current of 24 volts (d. c.) with and output of 500 watts. The necessary alternating current is obtained from this machine either by means of a transformer or by the use of an alternating current generator coupled to the turbine. Three main circuits are supplied with current having frequencies of 500, 1 000 and 2 000 Hz at 20, 30 or 60 volts.

In these three main circuits is connected a locomotive magnet combined for three frequencies, and a main relay for each frequency, which relay again controls a direct-current circuit. In these three direct-current circuits are inserted those portions of the apparatus which are necessary for producing the desired operation of the brakes, etc.

The locomotive magnet (see fig. 8) does not project beyond the rolling stock loading gauge limits even when the locomotive is fully loaded; the track magnet is placed 35 mm. (1 3/8 inch) above rail level and 15 mm. (5/8 inch) outside the

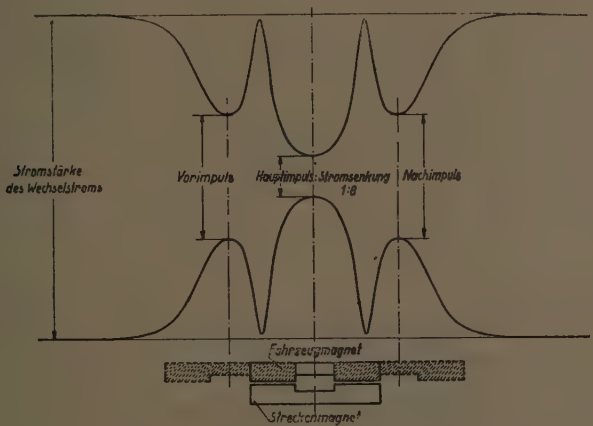


Fig. 10. — Inductive train control. Oscillograph of phenomena set up.

Explanation of German terms:
Hauptimpuls; Stromsenkung = Main impulse; Drop of current. — Nachimpuls = Subsequent impulse. — Stromstärke des Wechselstroms = Intensity of alternating current. — Vorimpuls = Foregoing impulse.

construction gauge (see fig. 9). It is placed on the outer side of the right hand rail and is secured to the sleepers. Like the locomotive magnet, the track magnet consists of a laminated iron core with coil and condenser and is contained in a casing made of silumin. Under an average loading of the engine the air gap between the track magnet and the locomotive magnet amounts to 140 mm. (5 1/2 inches) and when fully loaded to 115 mm. (4 1/2 inches). The transmission of the required inductive effect is secured by tuning the track electro-magnet with the circuit on the locomotive; *no separate source of current supply is required for the track circuit.*

This fact, which is not easily understood at first sight by engineers not specially familiar with this type of apparatus, is due to the so-called track magnet not being required to generate its own magnetic field, but operating solely as an absorber of lines of force and by its

mere presence producing a distortion of the field of the locomotive electromagnet as it passes by. This disturbance of the field reacts on the locomotive circuit generating it.

Figure 10 shows an oscillogram of the

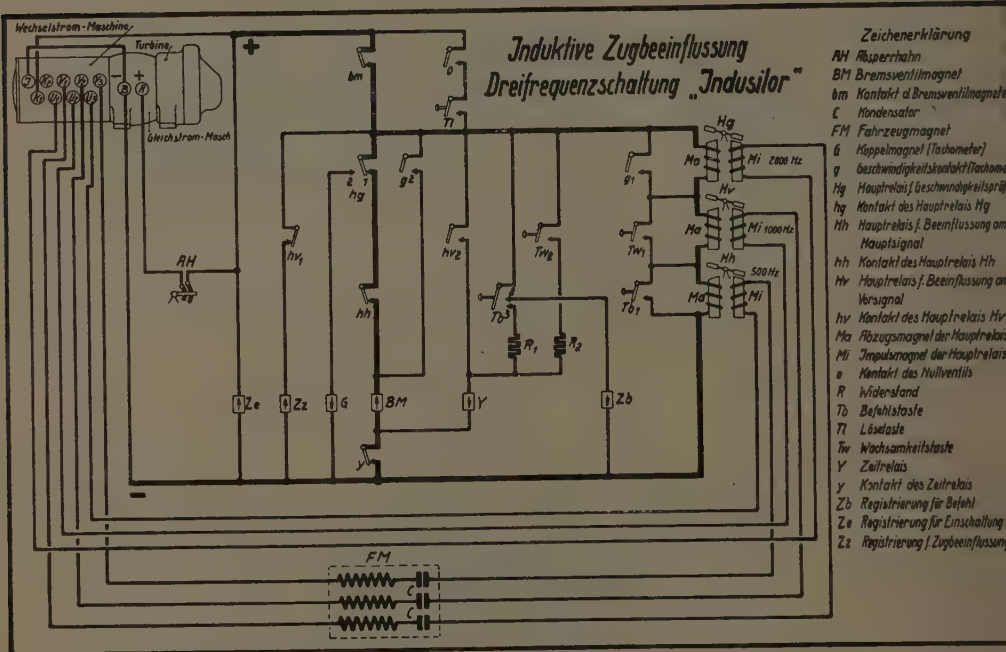


Fig. 11. — Inductive train control. Wiring diagram, 3-frequency « Indusilor ».

Explanation :

AH = Cut-out cock.
BM = Brake valve magnet.
bm = Contact of brake valve magnet.
C = Condenser.
FM = Vehicle magnet.
G = Coupling electromagnet (tachometer).
g = Speed contact (tachometer).
H*g* = Main relay (speed control).
hg = Contact of main relay H*g*.
H*h* = Main relay for control at home signal.
hh = Contact of main relay H*h*.
H*v* = Main relay for control at distant signal.
hv = Contact of main relay H*v*.
M*a* = Pull-off magnet of main relays.
M*i* = Holding magnet of main relays.
o = Contact of « zero » valve.
R = Resistance.
T*b* = « Command » press-button (to be pressed by driver when ordered to pass home signal at *danger*).
T*l* = Release press-button.
T*w* = « Alert » press-button.
Y = Time relay.
y = Time relay contact.
Z*b* = Recording home signal *at danger* passed by « order ».
Z*e* = Recording when control apparatus is cut out of, or replaced into, train control circuit.
Z*z* = Recording automatic train control.

disturbing process. At the instant the control operation takes place, the current in the circuit is reduced to such an extent that it is no longer able to hold up the armature of the main relay in the circuit. As soon as the armature

of this main relay is released the apparatus is free to perform any required operation on the locomotive itself.

While under the influence of the magnetic field of the locomotive, a feeble induced current flows in the windings of the track magnet. But it is only when this induced current is in resonance with the field of the locomotive magnet that a sufficiently powerful transmissive effect is produced; otherwise it will not suffice to release the relay on the locomotive.

Accordingly the variable function of the track magnet when the signal is in the *off* position and *at danger* is governed by opening or closing the condenser circuit of the track magnet. In order to secure this, as has been stated under A, the condenser is connected by wires to a contact mounted on the signal in question, as has already been indicated under A. If no transmissive effect is to be produced, the condenser is short-circuited by the signal contact, that is to say, the track magnet circuit is not in tune. When the signal is at danger the contacts are open, the condenser and hence also the track magnet become operative.

The first mechanical effect of this influence is, as has been shown, the releasing of the armature of the relay on the locomotive. The further operations on individual parts, such as brake valve, speed regulator, etc., are in the case of most of the trial locomotives carried out by electrical means. In a smaller proportion of the locomotives compressed air is made use of for transmission purposes.

Figure 11 shows the construction of the *electrical equipment*. On the left we see the turbo-generator, which feeds the following circuits :

1. The alternating current circuits, already referred to, which produce the alternating magnetic fields of the locomotive magnet *F M*. In each of these circuits is a holding magnet *Mi* for the main relay (*Hh, Hv* or *Hg*) according to the proper frequency.

2. A direct-current circuit. This serves first of all to excite the three pull-off magnets *Ma*. One such pull-off magnet is allotted to each holding magnet *Mi*, the reason for this being that the weakening of the alternating current by the inductive effect from outside the train only lasts for a fraction of a second when the train's speed is high and with so short an interruption of current, release of the relay armature could not be effected without some auxiliary force tending to pull the armature away from the holding magnet.

Once the armature is held up to the pole of the pull-off magnet, the re-excitation of the holding magnet is not capable of fetching it back into position again, because it is not strong enough to operate owing to the air gap between the armature and the pole.

Originally the work of the pull-off magnet was done by means of a spring. The pull-off magnet is to be preferred because with small irregularities in the current generated, the pull-off magnet is weakened equally with the holding magnet, whereas a spring has an unvarying tension and if the current should be reduced it would immediately pull-off the holding magnet. Moreover, in the case of the spring, a return relay arrangement is necessary so that the method is less simple.

In addition to the three pull-off magnets, the continuous current circuit operates several auxiliary relays which serve to convert the movement of the main relay into the different functional operations.

The process works most simply when passing a home signal at danger. The effect of the track 500-Hz magnet, at the home signal, weakens the holding power of the magnet *Mi* of the main relay *Hh*. The pull-off magnet *Ma* thus pulls on the armature of *Hh*, which again

opens the contact *Hh*. This interrupts the current passing through the brake magnet *B M*. The armature of the brake magnet, in falling away, opens the brake valve of the automatic control and the train is brought to a standstill.

At the same time the armature as it falls off also opens the contact *bm* on the brake magnet and thereby interrupts the current supply to the pull-off magnet *Ma*. The result of this is that the main relay *Hv* is once more attracted by its holding magnet *Mi* and the contact *hh* is thereby again closed. The brake magnet can at this moment not yet obtain current because the connection to the positive pole of the source of current supply is interrupted at *bm*.

In order to enable him to release the brakes on the train, the driver must make use of the « release » press-button contact *Tl* situated in the cab. This action will however only be effective provided the so-called « zero-valve » has first closed the contact O; the zero-valve however only operates after complete evacuation of the train pipe which means that the train must first of all come to rest.

If contact O is closed and *Tl* is operated an auxliary circuit is made which connects the brake magnet once more to the positive pole of the generator. This closes the brake valve and the driver is now enabled to release the brakes on the train.

The relay *Zz* serves to make a record of the process.

In case of overrunning a home signal on command (A), the *Proceed* press button contact (« command » contact) *Tb* is to be made use of. Contact Tb_1 short circuits the winding of the pull-off magnet of the main relay *Hh*, so that the release of the armature and hence also the automatic braking of the train are prevented. The time relay *Y* receives current through Tb_3 and after about 45 seconds operates the brakes, provided the « Command » press-button is kept pressed down beyond this period. The operation of the « Command » press-button *Tb* is recorded by the relay *Zb*.

When passing a speed control magnet — it being assumed that there is a home signal in the *danger* position or a gantry or semaphore carrying a number of signals for branch lines — the main relay *Hg* operates the contact *hg*. If at this moment the speed *exceeds* the permitted limit, the effects as also the measures to be taken to re-start the train are the same as described above. It is true that the contact *hg* has a further function, inasmuch as it supplies relay *G* with current, whereby the tachometer contacts g_1 and g_2 are closed; this action has however no further result, because at *excess speed* an insulating plate operated by the tachometer is moved over these contacts and the passage of current at that point is prevented.

The position is different when the speed remains *within permissible limits*. Then contact g_2 operates and switches in an auxiliary circuit which prevents the brake valve magnet *BM* from falling and the contact *bm* from opening. In consequence, no braking takes place. As, in addition, the pull-off magnet *Ma* of the main relay is short-circuited by the contact g_1, the holding magnet pulls the armature back into its normal position.

The speed control therefore becomes non-operative when the speed does not exceed permissible limits. Great importance is attached to the fact that no special tachometer is utilized for speed control purposes, but only the Deuta tachometer which is fitted to nearly every locomotive and which the driver is accustomed to go by. The employment of a special tachometer which he would be unable to observe might lead to difficulties.

In the case of automatic train control

at distant signals, the following operations take place :

The pulling off of the armature of the main relay *Hv* when passing a distant signal (assuming that the distant signal is at caution) operates the contacts hv_1 and hv_2. hv_1 closes the circuit of the recording arrangement *Zz*, hv_2 operates the time relay *Y*. Should the driver be inattentive and fail to press the « alert » contact button *Tw*, contact *y* opens after a period of seven seconds. As a result the same effects are brought about as in the case of passing a home signal at danger.

If, on the other hand, the « alert » contact button *Tw* is operated in good time before the lapse of seven seconds, contact Tw_1 closes and short circuits the pull-off magnet *Ma*. As a result the armature of the main relay *Hv* is pulled back into its original position and the same thing takes place with contacts hv_1 and hv_2. The operation of the « alert » contact button is likewise recorded. As the « alert » contact button springs back after it is operated, the time relay *Y*, which works by the heating of a glow lamp filament, loses its current and returns to its original condition.

Should the driver, against his instructions, hold down the « alert » contact button for a longer period, the time relay continues to receive current via contact Tw_2, contact *y* opens after about three seconds and the brake magnet *BM* now comes into operation. It is clear from the diagram of connections that anticipated operation of the « alert » contact button at some point on the line before the distant signal is reached, would be ineffective.

It will be noticeable that different periods are stated for the operation of the time relay. These differences in the operation period with the different processes are effected by corresponding grading of the resistances in the circuits in question.

In conclusion, the following special points in the installation call for notice :

A main stop cock *AH* puts the whole automatic train control gear of the locomotive out of action. It shuts off the brake valve from the train pipe and breaks the direct-current circuit of the turbine.

The necessity for a main disconnector arises from the fact that the apparatus is built on the closed-circuit principle. Disturbances in the train control apparatus on the locomotive must be noticed by the driver and must cause him to

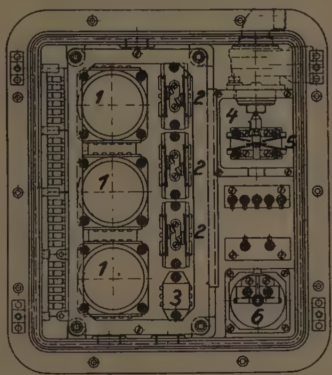


Fig. 12. — Inductive train control.
Control board.

Explanation: 1 = Main relay. — 2 = Distribution relay. — 3 = Time relay. — 4 = Brake valve with its electromagnet. — 5 = Contact *bm*. — 6 = « Zero » valve with contact.

cut them out. It is desirable to obviate that such disturbances should remain unobserved for longer periods. The relay *Ze* records the cutting out of the apparatus; the driver is bound to report the occurrence as soon as possible.

Figure 12 shows the construction of the arrangement and figure 13 the general arrangement of the Indusilor on the locomotive and in the track.

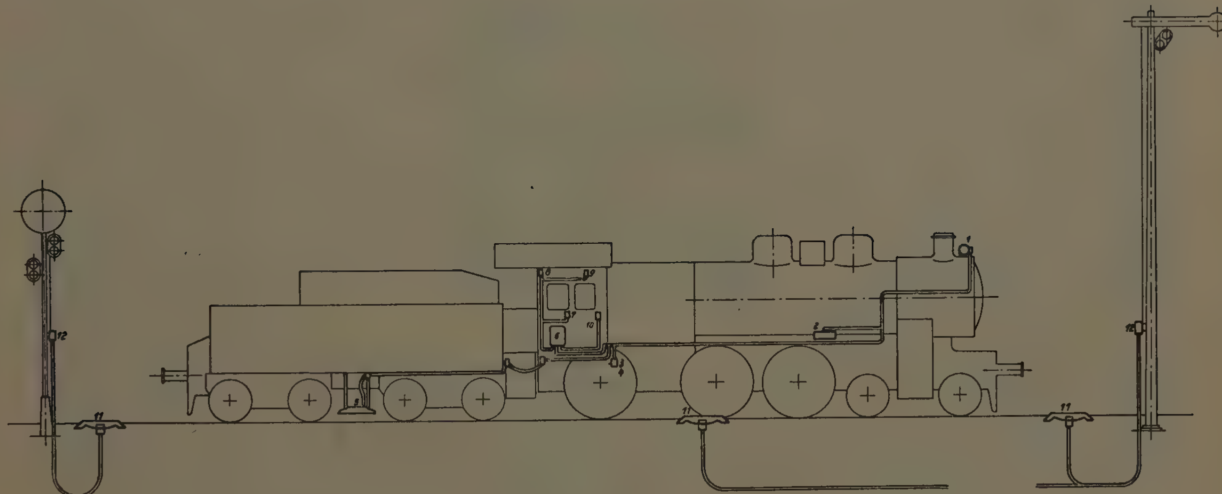


Fig. 13. — Inductive train control. General arrangement of locomotive and track fittings

Explanation :

1. Turbo-generator set.
2. Transformer.
3. Main cut-out lever.
4. Cut-out valve.
5. Vehicle electromagnet.
6. Control board.
7. « Alert » key.
8. Press-button for passing signal *at danger* (by order).
9. Voltmeter.
10. Tachometer.
11. Track electromagnet.
12. Blade-shaped circuit breaker.

3. Optical train control (Opsi) Bäseler-Zeiss design.

A. *Mode of operation.* — With the optical train control we are likewise dealing with a system which operates at given points. The arrangement works on the compressed air brake and is principally intended to bring the train to a standstill in front of home signals standing in the danger position. In order to solve this problem a graded speed limit is provided for in the Opsi system, for the reason that the advantages of this type are best brought out under this scheme of running. In the case of the graded speed limitation, several (generally three) operating points are installed between the distant and home signal and one such point at the home signal itself. Each train control point is allotted a particular speed limit, the extent of which decreases in accordance with the braking curve from a maximum value at the first control point down to 0 km./h. at the home signal.

Should at any control point the speed limit proper to that point be exceeded, the train is automatically braked till it

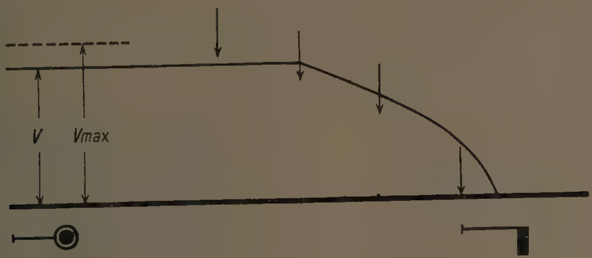


Fig. 14.

comes to rest. Figure 14 shows how a train running at a speed v, which, having maintained its speed in spite of a danger signal, it brought to a standstill at the second control point. The stoppage does not actually take place at the home signal but the interval beyond the home signal equal to the braking distance is also utilized. For trains running with brake adjustment suitable for freight trains the speed limits will naturally vary from those applying to passenger or express trains. This does not call for any additional apparatus on the track but the adjustment for the different braking conditions can be made on that part of the apparatus which is carried by the locomotive.

Operation at the individual control points is effected when the home signal stands at danger; in addition when the signal indicates that the train is to be run at a limited speed, those control points, which control a speed limit above the maximum indicated by the signal aspect in question, remain effective. In cases where the train is free to be run without any speed limits, all control points are out of action.

The question as to the choice of control points under the system of graded speed limitation is still a debatable subject. It would be desirable if it were possible to displace the control points at such distances beyond the home signal, that would enable the train to be pulled up by a voluntary application of the brake with the most favourable, that is, the steepest braking curve, even if this application were rather belated but

could be made just in time without necessitating obligatory braking induced by the graded speed arrangement. In thus choosing the position of the control points, one would have to reckon with the case of an unfavourable flat braking

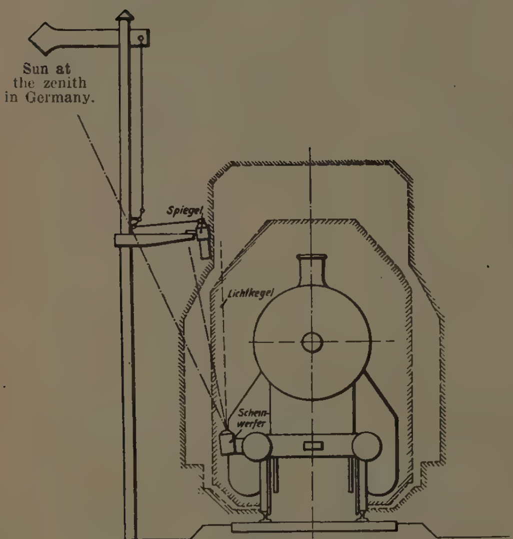


Fig. 15.

Explanation of German terms:
Spiegel = Mirror. — Lichtkegel = Light beam.
Scheinwerfer = Projector.

curve and long braking distance, so that for many types of trains very long intervals would have to be provided between the home signal and the danger point and this could only be achieved by costly displacements of signals. Advocates of graded speed limitation are in favour of basing the choice of the location of control points on the usual sequence of early application of brakes instead of delayed braking and to move the speed limits further away from the home signal, which results in materially diminished braking distances being required between the home signal and the danger point.

Apart from the attitude which may be taken in regard to this question, the case must be taken into consideration that the driver of a fast train will, in a thick fog, only get a sight of the distant signal at the last moment and will only apply his brakes at the moment of passing same. The first control point must therefore be placed at least so far beyond the distant signal that the automatic speed limitation would in such case not tend to interfere unduly with the action of the driver; in addition to this the distance from the first control point up to the danger point must suffice for the full braking distance under maximum speed in order to bring the train to rest in good time in the event of inattention on the part of the driver. Where the distance between home and distant signal is moderate, the conditions call for a braking distance of 150 to 200 m. (500 to 650 feet) and the corresponding displacement of the signals.

Operation with graded speed limitation would likewise be possible with the Indusilor 3-frequency system described above. In this case there could likewise be installed without difficulty several control points with varying speed limits. If we depend nevertheless principally on the use of the « alert » press-button contact as is the case in the Indusilor type which has hitherto been given preference, and the limitation of speed be only a secondary consideration, such policy is mainly governed by considerations of economy. The « alert » system permits of gradual development of the track installation (in the first instance, control at the distant signal only and later on the addition of further control points). In the graded speed control system one has to start right away with several control points between the home and distant signal and having special sources of energy. As a secondary consideration, difficulties

stand in the way of a decision in favour of the speed system, which are brought about in the choice of the different control points in consequence of the dependence of the braking distances on the make up of the train, the type of brakes and the state of the weather, more especially if fast goods trains and ordinary goods trains are to be dealt with. Moreover, the Opsi system can be converted to the « alert » system. In this case, however, material technical advantages in the Opsi type would not be made use of.

In the Opsi system with graded speed control security for maintaining the attention of the driver depends principally on the choice of the operating points. If these points are so selected

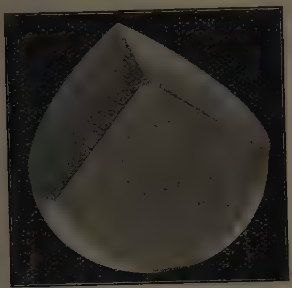


Fig. 16.

that the driver cannot depend on his train coming to rest in the proper way before reaching the home signal, if he relies on the functioning of the operating gear, there is just as little reason to fear lack of attention, as is the case with the system described earlier in this paper; true it would be necessary to provide for a record of obligatory braking with the Opsi system by the provision of suitable apparatus.

Provision is also made in the Opsi system for preventing the operation of the brakes when passing a signal which is out of order as well as the installation of a lever for cutting off the whole of the train control apparatus on the locomotive.

B. *Description.* — Transmission to the locomotive of the effect produced by the track apparatus is, in the case of the Opsi system, procured by means of light rays. The basic idea is as follows (see fig. 15). A projector mounted on the locomotive continuously emits a ray of light in an approximately vertical direction upwards. At each control point there is erected an arm at a height of about 4 m. (13 ft. 1 1/2 in.) above rail level and carrying a three-dimension mirror close to the line of the clearance

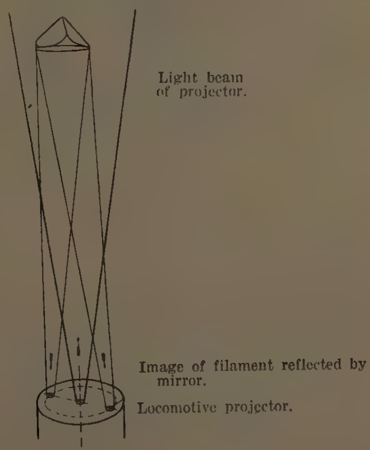


Fig. 17.

gauge. The distance between the projector and the mirror is about 3 m. (9 ft. 10 1/8 in.).

When the home signal is at *danger* the mirror is placed in such a position that the rays of light are directed back towards the projector on the locomotive. The reflected beam impinges on a sele-

nium cell which forms part of a current supply circuit. The cell under the influence of the light, closes the circuit, by the help of which the further necessary operations are carried out. The circuit of the selenium cell as likewise the bulb in the projector are fed from the turbo-generator supplying light to the locomotive.

Owing to the fact that strong sunlight likewise brings the selenium cell into operation, the direction of the ray of light in the Opsi system is, as has been already stated, placed in a nearly vertical position. For, in Germany the sun never stands so high that it could shine into the apparatus in this direction. In order to prevent action due to diffuse daylight which might fall on the cells, the light from the projector is artificially given a special character. In the casing of the projector is mounted a small wind vane connected to the compressed air pipe of the locomotive; it rotates a perforated disc and thereby cuts up the outgoing light into some 600 separate pulsations per second. The effect of this special form of light is separated from that of diffuse daylight by a simple artifice in the connections.

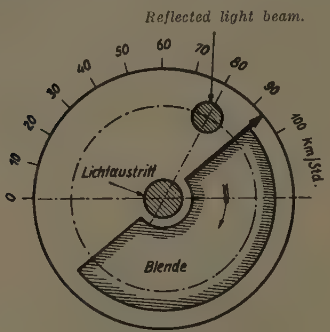


Fig. 18*a*.

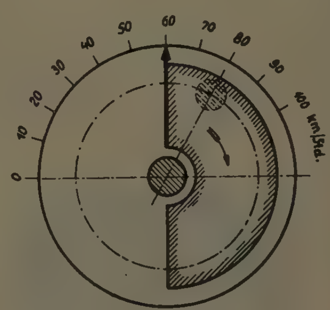


Fig. 18*b*.

Note:
Blende = Screen. — Lichtaustritt = Exit of light.

The track mirrors are protected by a tube (open at the bottom) from the effects of soot, snow and hoar frost. The projector on the locomotive is kept free of snow and ice by means of a self-contained heater. Fog or drifting snow are unable to interfere with the operation because the light from the projector is so powerful that it can safely pierce the necessary short distance of 6 metres.

The first conditions required for successful operation by the optical effect is that the mirror on the track should positively reflect the ray of light issuing from the locomotive back on to a fixed point (a small lens) on the projector of the locomotive, whence the light is directed to the selenium cell. The three-dimension Zeiss mirror (fig. 16) shows how this problem is solved. Its oblique surfaces correspond to a cube, one angle of which has been truncated. The light is reflected in the form of two beams which reach the edge of the projector at the side of the source of light and which lie diametrically opposite each other (fig. 17). Of the two beams only one is necessary for activating the selenium cell.

If all the track mirrors were installed

exactly alike, the spots of light would always fall on the same point beside the source of light. A very remarkable addition by Dr. Bäseler consists in varying the position of the angles of the mirrors with respect to the direction taken

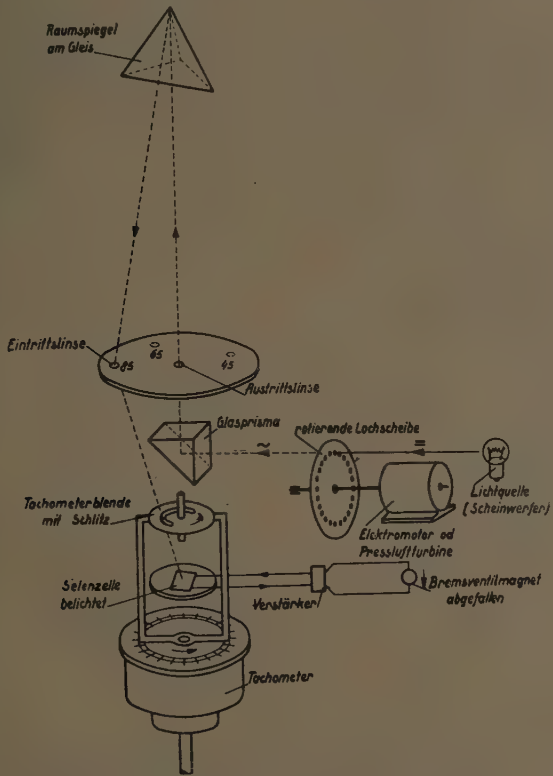


Fig. 19. — Diagrammatical arrangement of « Opsi ».

Explanation of German terms:

Austrittlinse = Outlet-lense. — Bremsventilmagnet abgefallen = Electromagnet of brake valve, armature off. — Eintrittlinse = Inlet-lense. — Elektromotor od. Pressluftturbine = Electric motor or compressed-air turbine. — Glassprisma = Glass prism. — Lichtquelle (Scheinwerfer) = Light source (projector). — Raumspiegel am Gleis = Three-dimension mirror on track. — Rotierende Lochscheibe = Perforated rotating disc. — Selenzelle belichtet = Selenium cell receiving light. — Tachometerblende mit Schlitz = Tachometer screen with slit.

by the rails at the different control points and thus throwing the rays on to different receiving lenses on the projector of the locomotive. These light-receiving points are grouped about the circumference of a circle of which the source of light is the centre.

Over this circle of light-receiving

points a crescent-shaped screen oscillates by the operation of a tachometer (fig. 18*a*). Hence at a particular speed of the train only a certain section of the circle is free to receive light, the remainder being screened (fig. 18*b*). By this device, the inventor has succeeded in providing in a simple manner a relation between the speed of the train and the operation of the train control apparatus (see also fig. 19).

If, for example, at a particular point a reduction in speed to 60 km./h. is to be effected, the track mirror at that point is mounted in such a way that the ray of light falls on to the point on the light receiving circle marked 60 km. If the train is running at a lesser speed the

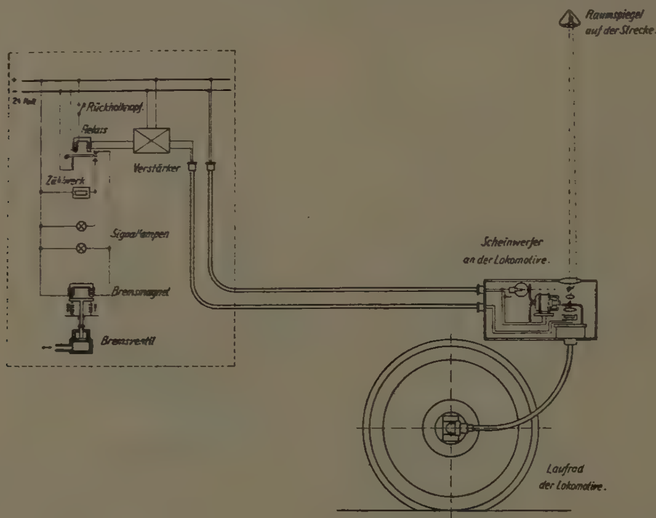


Fig. 20.

Explanation of German terms:

Bremsmagnet = Brake magnet. — Bremsventil = Brake valve. — Laufrad der Lokomotive = Carrying wheel of locomotive. — Rückholknopf = Re-setting button. — Raumspiegel auf der Strecke = Three-dimension mirror on the track. — Scheinwerfer an der Lokomotive = Locomotive projector. — Signallampen = Signal lamps. — Zählwerk = Counting mechanism.

60 km.-point is screened by the tachometer and the light is unable to operate. As soon as the speed of 60 km. is exceeded the light receiving point is exposed and obligatory braking takes place. At the home signals the beam of light is directed in such a manner that it reaches the selenium cell at any speed and thus produces unconditional application of the brakes.

The necessary removal of the effect at the train control point when a change of signal takes place is brought about by rotation of the mirror which results in the beam of light being directed away from the projector. At the home signal this rotation is very simply effected by a mechanical connection from the signal operating gear. The same problem as regards this movement at intermediate

points between distant and home signal is more difficult. Tentatively a special twin wire has been used, which is operated from a special driving sheave mounted on the home signal. So far, insufficient experience with this arrangement has as yet been obtained.

As explained, the immediate effect of the optical impulse on the train is to close the current circuit of the selenium cell. The further operation of this first effect is secured by passing the current first of all through several valve amplifiers until it has sufficient strength, when it is used for operating a relay. By the attraction of the armature of the relay a closed-circuit current is interrupted and this current normally serves to hold up the armature of the brake valve magnet in position. Accordingly interruption of the closed circuit current results in opening the brake valve (see fig. 20).

It should be noted that, as may be seen in figures 19 and 20, the same selenium cell, the same amplifier, the same relay, etc. are used for all degrees of speed. The reason for this is that in the Opsi system the tachometer already forms a controlling element in the transmission processus, whereas for example in the case of the Indusilor, it only comes into operation when the transmission process has arrived at a later stage and has been converted into an operating current. Reference may again be made to the effect that owing to the simple manner in which the speed of the train is brought into play, the Opsi system is more particularly worthy of consideration where graded speed limitation is to be effected.

IV. — Operating experiences.

The following remarks may be made regarding the reliability in service of the different types of automatic train control.

1. Sensitiveness to disturbing influences.

The mechanical stop, as has already been demonstrated under III, has been proved to be entirely undisturbed by outside influences of any kind in its sphere of application. The same is true of the Indusilor. Neither snow, ice nor excessive moisture in the air have been able to restrict the magnetic effects. So far no case has arisen where the locomotive magnet has been carried away by encountering masses of snow. Similarly, on railways using alternating current, no disturbing effects due to the power current have been experienced where the Indusilor is in use. In one particular case, certain track magnets were damaged and rendered ineffective, presumably owing to some object falling off the train. For the rest the few cases where the Indusilor failed can be ascribed to track magnets of an earlier design. With the present construction no failures have so far been noted.

If we base our conclusions on the results obtained under running conditions, these conclusions may, it is true, be deceptive. The reason for this is that under present-day running conditions in Germany, as regards express and passenger trains, it is a comparatively rare event to encounter a signal in the danger position; in other words, the train control apparatus is seldom under trial. For this reason numerous special runs have for years been undertaken with Indusilor-fitted locomotives, during which all the signals are set in the danger or caution position.

There was greater danger of disturbance by outside influences in the case of the Opsi system. Its operation depends to a great extent on the condition of the surface of the track mirror. Failures observed at the commencement due to hoar frost were remedied by the application of a layer of Cellon. Trouble due to condensation and to smoke in

tunnels has not yet been entirely removed.

2. *Unintentional operation.* — Such occurrences do not indeed imply an immediate danger to traffic but are the cause of undesirable delays. If they take place frequently it becomes necessary to put the apparatus on the locomotive out of action. The conditions for the rest of the run are then similar to the case when all operating points have been put out of action.

It is necessary to differentiate between unintentional operation of the gear due to outside influences and those due to disturbances or irregularities in the apparatus on the locomotive.

On account of its favourable position, the mechanical train stop lever does not suffer from disturbing influences. In the case of the Indusilor one could imagine that masses of iron stacked alongside the track such as steel sleepers or bridges might have an effect on the magnetic field of the locomotive magnet. Experience, however, goes to show that the bridges exercise no effect and that masses of iron will only then have an undesired influence so as to release the apparatus at the wrong times, if the material is stacked so close to the rails that it interferes with the clearance gauge limits and thus would constitute a danger to the rolling stock. In the case of the Opsi system, ample protection is provided against operation by outside influences.

Unintentional application of the brake due to irregularities in the parts carried on the locomotive occur very rarely in the case of the mechanical train stop on account of the simplicity of the construction of the different parts. In the case of the Indusilor, the sensitiveness is increased owing to its dependence on the running of the turbo-generator and to the fact that electrical apparatus such as relays are employed in its construction. In the early years of trials, the arrangement suffered in some locomotives owing to water entering the steam turbine; this defect as also certain individual faults in the electrical installation were cared for by improvements in design, so that nowadays in the locomotives which are already provided with these improvements, unintended operation hardly ever takes place. As a consequence the number of cases when the apparatus on the locomotive had to be cut out of action was very small.

In the case of the Opsi system the locomotive likewise contains in its apparatus a number of sensitive parts, for instance, the lamp in the projector, the selenium cell, the amplifiers, etc. In addition to that the working of the installation also depends on the turbo-generator. Trials made so far are still on a too restricted basis to enable one to judge of the extent to which the Opsi system is secure against unintended operation of the apparatus carried on the locomotive. The number of trial runs carried out without interruption makes us expect favourable results.

3. **Improvements contemplated.**

At the present time there is no reason for making fundamental improvements in the types of construction dealt with. On the other hand, changes will be made in details of construction as time goes on and as they are suggested by experience gained under running conditions.

V. — The question of cost.

The cost for supply and fitting of a motor coach installation amounted to 877 Rm. on the Berlin track sections. An electrically operated train stop in the track cost 2 000 Rm. and 600 Rm. when mechanically operated, that is by coupling with the signal mechanisms. Maintenance costs are small.

In the case of the Indusilor it is difficult to estimate the cost of introducing

the apparatus on a large scale, because, so far, installations have only been made at intervals and with frequent alterations of the patterns, so that quantity manufacture was not possible. It is estimated that the cost of the locomotive equipment inclusive of erection but without counting the turbo-generator would for substantial quantities be somewhat of the order of 3 000 to 5 000 Rm. per locomotive, while the track equipment, omitting for the time being the graded speed control, would come to about 1 200 to 1 600 Rm. per kilometre (1 930 and 2 575 Rm. per mile) of track reckoning with one home signal per kilometre (per 0.62 mile) of section. For the Opsi no estimates are as yet available.

Savings in running costs by the automatic operation of the trains are not to be anticipated in Germany owing to the completeness of the signalling arrangements which meet all requirements for the free movement of traffic; on the other hand, an increase in running costs would arise on account of supervision, maintenance and renewal of the apparatus.

VI. — Further extensions.

For several years, in Germany, attention was drawn to the overrunning of stop signals on account of the accidents which happened, involving many casualties, but in recent years this has not been the case. Altogether the frequency of accidents has greatly diminished, due principally to the falling off of traffic as a result of the economic conditions which brought about easier operation. Better attention is given to home signals on all German main lines on account, as has been said, of the warning boards which have been installed before the distant signal.

Under these circumstances and in view of the present difficult economic position of the Reichsbahn there is no prospect of a rapid development of the automatic train control system.

In any case, one must be prepared for the possible recurrence from time to time in the future of serious accidents due to non-observance of signals at danger; further it must not be forgotten that the signal and safety arrangements which have been developed at great expense, form an incomplete work if the last link in the chain of interdependence is missing, namely, the operation of the train being made positively dependent on the position of the signal. The introduction of automatic train control such as is described would enhance the value of the existing fixed safety devices. The progress made in the development of automatic train control by action at a distance justifies the certain expectation that it will fully meet the case.

In view of this, extension of this type of train control on all important main lines and on the locomotives running on them should be described as a desirable improvement, looked upon from the point of view of safety in working and of making the fullest possible use of safety devices.

CZECHOSLOVAKIA.

I. — Types and extent of application of automatic train control.

So far only a few trials have been made with a mechanical train control device and with an electro-magnetic direct-current system. Work is being done at present with a view to carrying out new trials on a larger scale and with up-to-date apparatus.

It is assumed that the cost of experiments and trials will be borne by the inventors or the works supplying the materials, without any obligation on the railway to take over any of the apparatus supplied.

A programme of trials on the lines indicated under II and III hereafter has been laid down.

II. — Aim of the system of automatic train control.

Like others, the Czechoslovakian State Railway administration looks upon this train control as an additional measure of safety; the removal of fixed signals or the automatic operation of trains would be considered dangerous, if only on account of the possibility of failures of the distant train control installation.

III. — Mode of operation and design.

A. *Mode of operation.* — The following plan of operation for the train control is being considered :

First of all, warning the driver by means of an acoustic or optical cab signal whenever the train passes a fixed signal or any other particular point at which braking should take place. Provision of an « alert » lever or « alert » push button for the purpose of confirming the warning received. This operation of the « alert » key is to be recorded. Obligatory braking shall only take place after the lapse of a definite period of time after the warning, and even then only if the driver has up to that moment delayed in taking the action which would be incumbent on him at the time.

A scheme of this description resembles essentially the German type Indusilor for train control at distant signals, with this difference that with the Indusilor the cab warning signal is omitted as its function is in Germany performed by the warning boards erected at a suitable distance in front of the distant signal.

It has been noted as desirable that the actual position of the distant and home signal should be indicated by means of special optical or acoustic signals in the driver's cab; as however it is feared that such addition would, in the case of systems operating at fixed points, lead to a very complicated design and in addition might cause the driver to neglect his look-out on the section, it has been decided to leave the *line clear* warning out of the scheme.

In order to enable a train to pass a home signal which is out of order, a sealed « Proceed » press button will be arranged for by means of which the operation of the train controls can be cut off. A record will be made of the employment of this « Proceed » key; if the press button is held down for an extended period, the brakes will automatically come into operation.

With the object of maintaining the attention of the driver, the following methods will serve:

1. The « alert » press button switch already referred to.

2. Strict instructions regarding the use of the « Proceed » key.

3. Avoidance of arrangements which would enable the operation of the train control to be nullified by making use of the driver's brake valve.

4. Recording all movements made by the driver in connection with the train control apparatus and of all impulses which are received by it from the track.

B. *Technical details.* — The Czechoslovakian State Railways are of opinion that on express lines arrangements which involve mechanical contact between an object secured to the track and a part of the locomotive, are unsuitable. This refers both to the purely mechanical and the so-called electro-mechanical types of construction for train control.

It is the intention to design the train

control apparatus carried on the locomotive on the closed-circuit current principle.

IV. — Attitude toward automatic train-control.

Two reasons are principally responsible for the fact that in Czechoslovakia the question of automatic train control has been treated up to now with a certain amount of hesitation. On the one hand there existed an impression that the types being tried out or actually in use in other countries did not, after all, comply with all traffic requirements. On the other hand, it was desired to solve by other methods, certain problems, which would normally form part of the automatic train control system. It was a question of adopting the following measures :

a) Increase from 100 to 200 m. (325 to 650 feet) of the braking distance behind the home signal.

b) Introduction of distant signals in the block system.

c) Arrangement of inter-dependence between the block service and the running of the trains.

d) Clearing the line for entry into stations of non-stopping trains only when the outgoing section is clear.

e) Improvement of night signal aspects at home and distant signals.

If these measures are to be treated as of primary importance, it does not necessarily mean that opinion in Czechoslovakia is antagonistic to automatic train control. Rather there exists the conviction that the introduction of automatic train control should be the last step towards completion of traffic safety. Special attention is devoted to the question as to what advantages automatic train control would have to offer in connection with fast train service on steam-operated lines where frequent fogs, heavy gradients or other special conditions are inimical to safe running.

SUMMARY.

1. For railway systems where the rails are entirely or partly laid on steel sleepers, only systems acting at fixed points come into question in view of the present technical position in railway construction.

2. The mechanical train stop has proved itself, in city and suburban traffic as a satisfactory and reliable point control system. The transmitting elements must, however, be placed high enough to prevent any interference by snow or other deposits on the permanent way.

3. A useful point system for express lines has been found in the alternating current induction types working at medium frequencies and which do not call for a source of supply from the track and are solely controlled by contacts at the signals.

4. The chief duty of automatic train control is to ensure the stoppage of the train when the home signal is at danger. Arrangements are considered advisable, which are capable of ensuring a reduction in speed when a home signal is passed or when traversing sections where a speed limit is obligatory.

5. It is considered necessary with the different point (intermittent) systems to design the automatic train control as far as possible in such a way that the attention of the driver is not distracted from observing the section, by the knowledge that such an apparatus is in existence on the section. Automatic train control is therefore not to be considered as taking the place of existing fixed signals.

6. For lines where the braking dis-

tances are short throughout, it will suffice, in order to draw attention to the danger signal, that the effect taking place at the point where the home signal is erected, should operate on the brake, provided, however, that the home signal is placed at braking distance before the danger point.

7. Where the braking distances are long and hence a corresponding displacement of the home signal is impracticable, the effect on the brakes must take place at a point *before* the home signal is reached.

8. In regard to determining the number and location of the controlling points in front of the home signal, it is a question either of an « alert » system, in which case the minimum requirement would be *one* operating point in the neighbourhood of the distant signal or an arrangement of graded speed limitation.

9. With the « alert » system it is desirable to amplify the arrangement by means of a second control point at the home signal and at specially dangerous points by introducing a speed-limiting control point before the home signal is reached, in order to nullify any danger due to errors of observation of the home signal during transit between the distant and the home signal.

10. The following measures come into question in order to provide against relaxed attention on the part of the driver:

a) Omission as far as possible of any arrangement which would serve the driver as an alarm clock. Warning signals to indicate the position of distant signals, where warning boards are installed in advance, appear to be superfluous.

b) Operation of the automatic control only to take place when inattention on the part of the driver becomes evident, either due to neglect in using the « alert » apparatus or on account of his exceeding a certain speed limit. In other words, late action by the automatic control. This makes it a condition that with fast trains the control shall operate on the brake as in this case there is no margin for delay.

c) Prescription of arrangements which enable the obligatory braking to be cut out, for example, by means of the driver's brake valve before the train has come to a standstill.

d) Provision against too early operation of the « alert » apparatus when the « alert » system is installed. Where heavy fogs may be encountered, operation by the driver of the « alert » gear should only become effective after passing the distant signal.

e) Recording of all movements by the driver in connection with parts of the train control apparatus and of all impulses received from the track and this as far as possible in combination with a speed record roll so arranged that the point on the line where the various actions have taken place may be recognized.

11. Provision of adequate drifting intervals beyond the home signal is necessary. The dimensions of these intervals will vary in accordance with the location chosen for the operating points and with the mode of operation of the train control. A distance of 150 to 200 metres (500 to 650 feet) will in many cases suffice.

12. An arrangement is required which will enable the driver to pass a home signal which is out of order, and a means by which in a case of interference the control apparatus on the train itself may be switched off.

13. For types which call for an electric current supply on the locomotive, the use of the lighting generator will come into question.

14. In order that defects in the train

control apparatus may be observed in good time, the closed-circuit current principle is recommended for the apparatus on the engine using electric current; in addition a test of the automatic control should be made before every trip. In point (intermittent) control systems regular testing of the parts fixed to the track is of importance.

15. Automatic train control forms an important part of the general system of safety. Its installation is recommended as far as is permissible with due consideration to the economic position and to other requirements of the railways. It is a condition that the type should be carefully tried out by means of extensive tests before it is adopted.

[628. 175]

Permanent way relaying[1],

by F. TETTELIN,

Chief Engineer for Works and Maintenance of the French Nord Railway.

(Extract from the *Mémoires et Compte rendu des Travaux de la Société des Ingénieurs Civils de France* (*Minutes of the Proceedings of the Society of Civils Engineers of France*) (issue of March-April, 1931).

Before speaking of the mechanical appliances in use when relaying running lines, it is worth while giving an idea of the magnitude of relaying operations.

Magnitude of the annual relaying work on the big French systems.

The mileage of the big French railway systems amounts to approximately 39 000 km. (24 235 miles). In some parts there is a single running track, in other parts two, sometimes more, so that the total length of single running track amounts to nearly 60 000 km. (37 283 miles).

The permanent way wears away under traffic and its complete replacement is effected periodically, according to a scale which is at present on the average 3 % per annum for the aggregate of the French Railways; this represents an average life of 33 years. This mean life

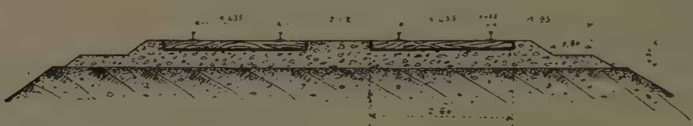


Fig. 1.

of 33 years involves the replacement of about 1 800 km. (1 118 miles) of running track annually; the figure is an average one, since some very busy lines have a much shorter life, whilst those with a small volume of traffic have a much longer one.

It would consequently be erroneous to regard this period of 33 years as being representative of the life of any given portion of track.

In the period between two relayings, the track receives regular maintenance which keeps it in good condition: tightening of the fastenings, packing of the sleepers, adjustment of the gradients or replacement of damaged parts, etc.

The replacement each year of 1 800 km. of running track represents an important undertaking, involving heavy expenditure in labour and material, costing more than 300 million francs, and constitutes a serious obstacle to the operation, since as a rule trains cannot pass, through a section being re-laid, at a greater speed than 30 km. (18.6 miles) per hour, thereby necessitating speed reductions even on unrestricted sections.

Of what parts is the permanent way composed? Figure 1 represents a cross section of a double track road. On the formation, which is determined according to the gradients, alignments and curves

(1) See the report of the meeting on the 23 January 1931, of the Society of Civil Engineers of France, page 90, summary of the paper and account of the discussion following it.

of the centre line, is placed a mattress of gravel about 50 cm. (10 inches) thick, termed the « ballast ». Resting on the ballast are the two tracks proper consisting of sleepers, usually of timber, and rails secured to them by means of coach screws. Relaying consists of dismantling the whole of the track (rails, sleepers), cleansing the ballast and replacing the old materials by new. As the rails weigh up to 46 kgr. per lineal metre (92.7 lb. per yard), and as they now have a length reaching 18 to 24 metres (59 to 79 feet), the weight of a rail is from 828 to 1 104 kgr. (1 825 to 2 433 lb.). The 24-m. rails rest on 40 or 42 sleepers, usually of oak or beech.

The ends of two adjacent rails are joined by two bolted fish plates, which grip the rails as firmly as though they were in one continuous length. The weight of a section of track 24 m. long is, therefore, about 5 600 kgr. (12 340 lb.) representing 233 metric tons per kilometre (369 English tons per mile).

The complete replacement of the 1 800 km. (1 118 miles) of track yearly involves, therefore, on the one hand the removal and on the other hand the placing of a mass of materials (steel and timber) whose total weight is 838 000 metric tons (824 600 Engl. tons). To this the ballast must be added — which has to be renewed more or less completely. If it is reckoned that about 2 tons per metre (0.6 Engl. ton per foot) run is a fair figure for the amount of ballast either taken away or put down, we arrive at a weight of 3 600 000 metric (35 425 000 Engl.) tons, making the total load to be handled equal to more than 4 400 000 metric (4 330 000 Engl.) tons.

If all this turnover of material was concentrated at a given point, in a yard for example, there is no doubt that long ago, mechanical appliances would have been utilised for handling it; but actually the work is spread out over the 39 000 km (24 235 miles) of the French Railways; its location changes yearly and the work is done in the open country so that it is impossible to bring to its execution any kind of fixed machinery: the relaying is carried out in consecutive sections and until 1909 the whole of the work was performed by manual labour in the following manner.

A. — Relaying by manual labour.

The line is cut behind a train and all the parts are dismantled—coach screws, bolts, rails, sleepers—along a certain length, and they are speedily replaced by new materials, previously placed in readiness, so as to restore the continuity of the road before the arrival of the next train. Work is resumed during the next favourable interval. The cleansing, substitution and packing of the ballast is likewise conducted in such a manner as not to interfere with the passage of trains.

It is consequently necessary to find between trains, sufficiently long intervals, not only to effect the interchange on all the sections of road, but also to allow for the standing at the site of the ballast trains which bring the new materials (rails, sleepers, fastenings and ballast) and of the ballast trains which remove the old materials and rubbish.

The film exhibited at the meeting shews the relaying operations carried out in the above manner, thus enabling appreciation to be made of the progress accomplished by the use of mechanical appliances.

The films give no idea of the time taken over the work, otherwise their exhibition would occupy too long a period; they shew all the processes in their proper order but each one lasts a few moments only.

FILM No. 1.

Relaying by manual labour.

I. *Unloading the materials.* — The film shews a ballast train, from which

are being unloaded the materials along the line as near as possible to the site of the relaying.

The wagons which contain the rails are provided with pulley blocks so that the rails may be lowered to the ground without shock.

The wagons containing the sleepers are of the flat variety or have drop sides. The sleepers are thrown to the ground from the wagons in some disorder, but when the train has moved away the men arrange them regularly alongside the track. (One sleeper weighs 80 kgr. [176 lb.]).

II. *Removal and cleansing of the ballast.* — Next comes the removal of the ballast. This is done by means of picks and shovels. The ballast is thrown on to screens with the object of separating the fine from the big stuff.

The fine stuff consists of dust and of dirt which has contaminated the ballast whilst in the track; the coarse stuff (consisting of shingle) will be used again after cleaning.

In order to remove the ballast from underneath the sleepers, the rails are wedged up by wooden blocks placed in the space between two sleepers.

All these operations take place on a track where the passage of trains is not interrupted. As soon as a train arrives all must be ready for it to pass without delay.

The clean ballast is then replaced in the track in such a way as to enable the blocks to be withdrawn and the track to be placed on a bed of clean ballast, which is of lesser depth than the original bed, but which will later be made up to its proper thickness by means of new ballast delivered by special train.

The provisional packing is done by means of shovels.

III. *Removal of the track.* — After a train has passed, the road is cut after having been protected by signals and also detonators placed 1 000 m. (3 300 feet) away.

The rails, then the sleepers, are removed in turn, the work being executed with great speed as only a short time is available.

IV. *Replacing the track.* — First the new sleepers and then the rails are placed by hand; a wooden square enables the ends to be kept opposite one another.

A packing piece is placed at the rail end to maintain the expansion joint; it is removed as soon as the work is finished. The first new rail is brought to the level of the adjacent old one by means of a jack whilst the fish plates and bolts are fitted, the coach screws, to the number of six per sleeper, are screwed home by means of hand-operated spanners.

A train is then allowed to pass over the section at reduced speed.

V. *Unloading of additional new ballast.* — The ballast train arrives and stops; the wagons (with drop sides) are opened and unloaded by hand with all speed; the train being emptied goes away; the ballast is then picked up by means of shovels to be placed in the desired position in the track; this is rather a slow process.

VI. *Picking up of old material.* — An empty train arrives; the old materials, rails and sleepers are loaded up by hand. This is rather a tiresome process.

VII. *Lifting and packing the road.* — The track is lifted by means of jacks and the sleepers are packed with the pick; then the rails are surfaced, the cess formed, and the ballast trimmed; the work is finished.

Remarks.

I. — It is worthy of note that if the relaying can proceed in this way at the rate of about 200 metres (656 feet) daily, the length of line over which the

track is disturbed is much greater, for the various operations—opening up the track, its removal and replacement, temporary packing, unloading and use of additional ballast, successive packings, alignment and levelling, etc., — are performed in rotation at sufficient intervals along the line so that any one operation is not held up by the previous one. This condition necessitates a total length of more than one kilometre (0.62 mile) which all trains must run at a speed not exceeding 30 km. (18.6 miles) an hour for passenger trains or 15 km. (9.3 miles) an hour for freight trains.

This feature should be borne in mind, because it will disappear for the greater part, with the use of mechanical appliances.

II. — The amount of man-handling necessary is fraught with some risk of accidents from which the men escape only by virtue of their training and skill : the film demonstrates several instances. The use of mechanical plant eliminates the greater part of these risks.

III. — You may have asked yourselves why the ballast has to be cleaned when the track is re-laid. It is sufficient to remember that during the thirty-three years of average life of the track, the ballast has been peppered by dust from the adjoining land, and this is by no means negligible in certain districts. Moreover, when packing the ballast with the pick, some of the stone is broken and reduced to dust. But mainly locomotive ashes must be taken into account. If it is agreed that a locomotive burns 16 kgr. of coal per kilometre (37.7 lb. per mile), giving 13 % of ashes, it produces 2 kgr. of ashes per kilometre (7.1 lb. per mile); say for 20 trains daily, 40 kgr. (142 lb. per mile) of ashes. In other words at the end of a year — nearly 15 000 kgr. per kilometre (52 250 lb. per mile) of track and at the end of 33 years nearly 500 tons.

Fortunately the whole of this does not fall on the track, the engine throws some of it into space as smoke; some of it remains in the ash pan until removed at the shed, but the remainder falls on the track. All these ashes and dust have the ultimate effect of contaminating the ballast; it is necessary to cleanse it in order to restore its original porosity, and the best time to do this is when relaying takes place. This cleaning of the ballast requires the largest of all the mechanical appliances which will be shewn to you.

B. — Relaying with mechanical equipment.

In 1927, the Permanent Way Department of the French Nord System investigated, in collaboration with Messrs. Drouard frères, the use of mechanical appliances, mounted on wagons, capable of moving over the site and by means of which nearly all manual labour was rendered unnecessary.

Thanks to the enterprise of Mr. Dautry, then my assistant, and now general manager of the State Railways, and of Mr. Cambournac, who has taken Mr. Dautry's place with me, the machines were built, perfected and tried out in 1928, so that since the beginning of 1929 they have been used with complete success on the Paris-Chantilly line.

Work started on the 21 January ; frost interrupted it from the 3 February to the 11 March ; at the start a daily progress of 144 metres (472 feet) was made; this increased to 360, 456, 504 and 576 m. (1 180, 1 496, 1 657 and 1 890 feet), and a normal output of 600 m. (1 970 feet) was the rate from the 9 May. It has even reached 648 m. (2 126 feet) on several occasions towards the conclusion of the work.

The 24 km. (15 miles) of one road were completely relaid by April 29th and the same length of the other road was finished by 21 June, which represents for the latter track an average of 570 m. (1 870 feet) per working day in spite of bad weather.

FILM 2.

Relaying the track by mechanical appliances.

(Drouard system.)

I. *Removal of the permanent way.* — The method is to take out a complete section of road consisting of a pair of rails with their sleepers. An electric crane mounted on a truck is made use of (see fig. 2), the current is supplied to a 50-B.H.P. electric motor from a generator driven by a petrol engine; 20 H.P. is taken by the winch, 5 by the lighting and 20 for the propulsion of the crane truck.

The crane travels on the road alongside that to be relaid; consequently on a double-track line these machines involve the occupation of both roads: the one for the relaying which is being carried out and the other for the machine to work on whilst standing and travelling. The crane can, in the above case, travel up to the empty wagons standing on the road to be cut — but beyond the part to be relaid during the given day

Fig. 2. — Drouard electric crane.

— and load up the section of track just removed and then return to the job and repeat the process.

II. *Cleaning the ballast.* — Supposing that a sufficient length of track has been taken up by the above method; on the adjacent road — reserved for the use of the machines — is a ballast removing and screening apparatus (fig. 3) which dredges the ballast off the cleared stretch of line by means of a bucket conveyor and sends it over a belt conveyor into a rotating cylinder pierced with holes through which pass the dust and fine material before being discharged laterally; the cleansed ballast falls on another band conveyor which returns it to the track.

The ballast removing and screening machine is followed by a truck on which is mounted a steam engine of 150 H.P. and a generator for the supply of current to the 12 electric motors.

III. *Relaying the track.* — As soon as the ballast is cleaned over a sufficient length, a start is made with the replace-

ment of the permanent way, the method being the reverse of that which we have examined for the stripping.

At the other end of the work, on the road being relaid, are placed trucks containing the assembled sections of the new material.

A second crane (there is one at each end) picks up a section and carries it to the site, where, the ballast having been treated, all is ready for the reception of the new permanent way, in continuation of that which has been previously laid.

The men have very little actual labour to do; they have only to guide the section so that it is lowered into the desired spot. Thus we have 24 m. (79 feet) of track placed in position. The fish plates are brought up on the section itself and they are fixed in position by hand by means of four bolts.

IV. *Unloading ballast brought by hopper wagons.* — A ballast train arrives, composed of wagons quite different from those of which we spoke earlier on; they are box wagons which our Rolling Stock Department has converted by adding two side discharge hoppers (fig. 4). The floor of these wagons is formed by two surfaces inclined towards the outside, so that the ballast slides of its own accord towards the hoppers.

Fig. 2. — Drouard ballast remover and screener.

The train advances slowly.

One wagon at a time is emptied and placed so that the contents fall opposite the work, in suitable quantities on each side of the track.

With this object, a man stands on a platform at the end of the truck and manipulates a lever opening the chutes in conformity with orders given him by a ganger who stands alongside the track.

When the wagon is empty, the next one is dealt with, and 600 tons are unloaded in this way, wagon by wagon, in half an hour.

At the rear of the train there are wagons with centre discharge hoppers, so that they discharge ballast between the rails; when the train is empty, ballast has thus been dumped at each side and in the middle of the rails. Shovelling by hand is thereby reduced to a minimum.

V. *Lifting and packing the track.* — The track is lifted to the proper level by means of jacks and the packing is performed, no longer by hand beaters, but by tamping machines, Collet pattern, driven electrically (fig. 5) and fed by a small power unit.

The rams penetrate the ballast, beating

Fig. 4. — Box wagons with side discharge hoppers.

Fig. 5. — Electric tamping machines (Collet type).

it sufficiently to compress it and force it under the sleepers. The ballast is trimmed off at the edges and the work is complete.

Remarks.

I. — The daily transport of permanent way material and ballast between the

depots and the site of the work was undertaken by special trains whose running was regulated to supply the work at the desired time.

The most careful arrangements were made and carried out to ensure the trains arriving on time, for punctuality in supplying was a necessary condition to the good execution of the work. Both the Traffic and the Locomotive Running Departments took all necessary measures in order that these results could be obtained.

I am happy to say that in all the Departments and in all the grades of the staff, those who participated in the relaying work devoted themselves zealously and with keenness, as they took the greatest interest in the progress which this new method involved.

II. — To leave a pair of running roads at the exclusive disposition of the Way and Works Department for a period of eight hours, either continuously or in two periods, was a problem not without its difficulties. It was necessary, in order to achieve it, to re-arrange the running of certain trains.

You are going to see how we managed to maintain practically unaltered the usual timetable of passenger trains.

a) Case of the 4-track line from Saint-Denis to Chantilly, in 1929 :

On this line of four roads (two for local trains and two for through trains) there had to be relaid a length of 24 km. (15 miles) between Saint-Denis and Orry, which was the double through line. It was only during the night from 10.0 p.m. to 6.0 a.m. that it was possible to concentrate the traffic of the four roads on two roads only.

On the length of 600 metres (1 970 feet) to be relaid each night, powerful acetylene or electric lamps were installed on posts placed at 10-m. (33-foot) intervals. The whole of the work was by this means powerfully illuminated. In addition, each mechanical appliance was equipped with its own electric lighting.

From 10.0 p. m. the two through roads were handed over to the Way & Works Department and all traffic passed over the two local lines with a resulting slight modification of several trains. At 6.0 a.m. the through roads were returned to the Traffic Department with slow-down signals at 30 km. (18.6 miles) per hour over the relayed length; these signals were replaced at 9.0 a.m. by a maximum speed signal for 80 km. (50 miles) per hour. At the end of three days this signal was removed and the speed of 120 km. (74.5 miles) authorised.

The deceleration of the train service was thus much less than for the former methods.

b) Case of the double line from Ormoy to Longueau, in 1930 :

The line from Ormoy to Longueau serves principally goods traffic between the Northern region and Le Bourget station, where the Nord lines connect with most of the other French systems.

The relaying was carried out between Tricot and Hargicourt along 32 km. 746 m. (20.34 miles) of single line, not during the night, but during the daytime.

The number of trains, however, using the line is considerable.

78 regular trains daily, of which 10 are passenger trains (inclusive of two expresses) and 68 are goods trains.

On the other hand 65 provisional trains are diagrammed.

It was not an easy task to stop all traffic on the line to be relaid, from 7.0 a.m. to 3.0 p.m. that is during 8 hours and, at the same time, 7 hours on the second line reserved for the machines.

The Traffic Department arranged matters :

1. By re-taking possession of the second line (previously vacated by the machines) for a period of 40 minutes from 10.40 a.m. to 11.20 a.m. and in using

it as a single line, between the nearest stations, for the use of passenger trains in the two directions at their usual times.

2. By substituting motor buses for two cancelled passenger trains between these two stations.

3. By delaying or advancing the running of about 20 goods trains.

III. — The ballast removing and screening plant, improved as a result of the experience gained in 1929, had an average daily output of nearly 700 m. (2 300 feet) and as its progress determines that of the other work, it is the factor limiting the daily average.

IV. — The mechanical plant requires the occupation of a road adjacent to that which is to be relaid. Without doubt that does not prevent its use on a double-track line, but it cannot be used for the relaying of a single-track line.

Mr. Loiseau, permanent way engineer of the French Nord Railway, developed a perfectly satisfactory solution which requires the occupation of only the road to be relaid, and which Mr. Déhé, one of our contractors, used, in 1930, at first on the Nord System on a 5-km. (3.2-mile) stretch of line between Douai and Valenciennes, then on the Est System (the line from Revigny to Vouziers) on a section of 15 km. (9.3 miles) and finally on the Etat System (the line from Mezidan to Mans) on a section of line 12 km. (7.5 miles) long.

Fig. 6. — Scheuchzer ballast remover.

The contractors used, as ballast remover and screener, a machine in service since 1928 on the Swiss Federal Railways, which was constructed by Mr. Scheuchzer in his workshops at Renens (Switzerland) and which is designed to travel on the same track as that from which it removes ballast. It pays for this advantage by a certain reduction in output as compared with the Drouard machine, but it is of considerable interest. It worked, of course, on the old track before the latter was removed.

Removal and cleansing of the ballast by the Scheuchzer system. Relaying of the track by the Loiseau system.

(Contractors : Messrs. Déhé).

I. *Removal and cleansing the ballast.* — The ballast remover is mounted on a motor-driven wagon (fig. 6).

The wagon is driven by a petrol motor and consists of a scarifier formed of prongs and arms to which a continuous movement is imparted by a Gall chain encircling a horizontal elliptical disc which is placed underneath the sleepers prior to the arrival at the site of the machine and which is then connected with the machine, so far as support and control are concerned, by members placed outside the line of the sleeper ends.

In front of and behind the excavator the rails rest on chocks, placed so that the ballast may be removed from below the sleepers to a depth capable of variation from 15 to 45 cm. (6 to 18 inches) according to the amount of stripping to be done.

At the same time as the scarifier turns, the wagon slowly advances and the disturbed ballast accumulates in front of a mechanical shovel which pushes it towards an endless bucket chain which in turn hoists and tips it into a cylinder where it is cleaned by rotation and screening.

The rubbish is discharged laterally. The clear shingle falls into the adjacent track : it can be made use of for packing the sleepers whilst the checks are withdraw behind the work.

With this machine it has been found possible to remove and screen the ballast

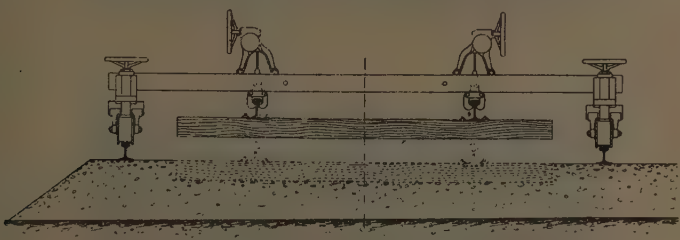


Fig. 7.

from 60 m. (197 feet) of track in an hour with the help of a gang of from 15 to 20 men.

II. *Features of the Loiseau machines.* — On the old track roughly ballasted, the Loiseau machines are used to remove and replace the permanent way in complete sections.

The process has the following features :

1. Neither truck nor skip is utilised for transporting the materials between the nearest station and the site ; the sections of permanent way are each fitted with four wheels which enable them to travel along the ordinary track.

The removal and placing of the sections of permanent way are accomplished by means of very light frames (fig. 7) which six men can lift in order to place them at the side of the line. A frame weighs 280 kgr. (617 lb.) and it is very low (60 cm. [2 feet] above the surface of the rail).

3. *Removal of the track.* — The frames are rolled along a track placed outside the normal road, and consisting of two lines of light rails (20 kgr. per m. [40.3 lb. per yard]), laid to a gauge of 3.20 m. (10 ft. 6 in.) roughly fixed on wood blocks 6 to 10 feet apart and merely resting on the ballast.

The frames are fitted with winches by means of which the section of road is lifted until the underside of the sleepers is higher than the rails of the

Fig. 8. — Loiseau frames raising a 24 m. (79-foot) section.

Fig. 9. — Section supported by four wheels on the normal track.

undisturbed track (fig. 8). (3 frames are enough to deal with a 24 m. [79-foot] section).

The frames are pushed by hand until they are over the next section. Then, under the rails of the suspended section, are fixed two pairs of wheels and axles.

By means of the winches, this section is lowered until the four wheels rest on the rails of the normal track (fig. 9) and it is then pushed clear of the work. The frames set free are then ready to lift the next section, over which they are actually situated.

The same process is repeated with successive sections.

Fig. 10. — Trolley car hauling ten sections.

Fig. 11. — Loading up fully assembled new sections.

The rolling apparatus and the frames were designed and manufactured by Messrs. Collet and embody the same principles as their trolley which combines extreme simplicity with great strength : no mechanical power is needed. The frames and the windlasses are operated entirely by manual labour.

When about ten of the displaced sections are accumulated clear of the actual work, they are coupled together and drawn like a train by a trolley car which takes them to the nearest station (fig. 10).

IV. — *Laying the permanent way.* —

This work is carried out by similar manœuvres, in the reverse order, by bringing the new sections from the station beyond the other end of the work and lowering them into the track which is thus constructed progressively.

The sections of new track were delivered in advance on trucks at the station and unloaded by travelling cranes (fig. 11), then the small axles and wheels were attached to them by means of which they were ready to be hauled on the normal track to the site of the relaying.

Likewise the old sections were loaded complete at the station beyond the other end of the works.

The renewal of the permanent way may reach a speed of the order of 200 m. (650 feet) an hour with 25 or 30 men, but the output of the ballast remover has not yet enabled this speed to be taken advantage of and to permit of such a high output.

V. — *Unloading the ballast. Lifting and packing the permanent way.* — The other operations, unloading ballast, lifting and packing, are performed by means of hopper wagons and mechanical tampers, as in the Drouard process.

Remarks.

I. — The track to be renewed (on 5 km. [3.2 miles] of the line between Douai and Valenciennes) was put at the disposal of the Permanent Way Service from 6.55 a.m. to 1.10 p.m. During this period single line working was instituted on the other road.

The ballast remover was at work for scarcely more than 4 1/2 hours on account of various hindrances and the time required to bring it up to the work and to take it away again; the relaying was taking place at a spot some considerable distance away from the station covering it.

Nevertheless, in this short initial trial of complete track renewal by the novel method, the output attained a figure of 244 m. (800 feet) per shift of 6 1/4 hours.

II. — The temporary track for the use of the frames is only necessary at any given time along the particular stretch of line where the permanent way is going to be removed, and it may be moved forward according to the progress of the relaying.

Its function is, in effect, to provide an auxiliary track for shifting the frames when the normal one on which they can travel is not available.

Assembly and dismantling of permanent way sections at the central workshops at Moulin-Neuf.

In order to supply the relaying works using mechanical appliances, special trains set off from Moulin-Neuf (near Persan-Beaumont) conveying the trucks loaded with new sections to the station situated on the far side of the works, and in the opposite direction they bring back to Moulin-Neuf the trucks loaded with the old sections from the station situated on the near side of the works.

This is what happens at Moulin-Neuf:

A yard has been provided for the purpose of assembling and dismantling sections of track, and it is equipped with railroad track, cranes and electrically-driven machines.

The spacing of the sleepers of a section is located by wooden brackets; the rails are brought into position by means of lifting tackle slung from gantries; the coach screws are driven home by means of Collect electric screwing machines (fig. 12).

The assembled sections are loaded on wagons by means of a travelling gantry crane (fig. 13).

The sections of old track arriving at Moulin-Neuf are dismantled there by similar methods, and the component parts are sorted into batches according to type and condition.

Fig. 12. — Driving coach screws with the Collet electric machines

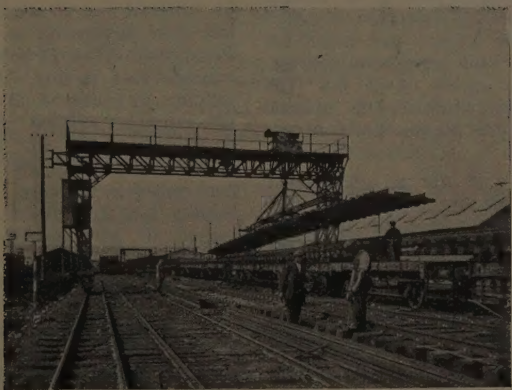


Fig. 13. — Loading up assembled sections.

The rails are made serviceable by cutting off their ends in order to get rid of the parts worn by the working of the fish plates. This makes available rail lengths whose only wear is a regular one along the top surface, that is to say, whose profile is shallower than it was originally. The sleepers are, so far as suitable, adzed and redrilled for further use. Thus there is a supply of serviceable materials available in good condition.

Remarks.

We have just described the complete cycle of operations, and if the new methods are compared with the manual

methods, it is clear that a considerable advance has been made.

1. In the first place an increased rate of working is obtained. Instead of a matter of 200 m. (650 feet) daily, which is obtained with difficulty by manual methods, mechanical equipment has regularly given outputs of 600 m. (1 950 feet) daily [and even reached 800 m. (2 600 feet) in 1930], during the same working period of 8 hours, and thus the hindrance to operation of the line due to relaying is reduced accordingly.

It is the ballast remover and screener which determines the output of work. Messrs. Drouard have succeeded in increasing the output from 150 to 180 m. (390 to 590 feet) an hour.

2. The employment of mechanical equipment gives an advantage as regards regularity in the running of trains, because it requires a reduction of speed to 30 km. (18.6 miles) per hour for three hours only and permits immediately afterwards a speed of 80 km. (50 miles, per hour, whereas the manual system requires the 30-km. limit all the time.

3. The output of 200 m. (650 feet) daily for relaying by man power requires a strength of at least 140 men, or 700 man-days per kilometre, whilst by mechanical means the ouput obtainned is 600 metres or more daily with about 125 men, that is 208 man-days per kilometre. This represents a saving of 70 % in man power for renewal of ordinary through road.

4. The machines eliminate the more onerous and sustained efforts required of the workmen, and as a corollary, the greater part of the risks of accident inherent to manual labour.

5. They result in the work being organised on a continuous basis through the linking together of the operations.

CONCLUSIONS.

At the present day, therefore, a variety of methods for renewing main line permanent way by mechanical processes is thus available. The choice to be made between the one or the other depends on local conditions, and these methods will go on improving, for they still form the object of study and experiment with a view to their perfection.

However, and I cannot stress this point too much, all these methods would be futile if the Traffic Department did not give possession of the road to the Permanent Way Department during a considerable period, altering the train service, as required, in a temporary but nevertheless radical manner. It has been seen, from the examples quoted above, that this has been done very generously in my case. I wish to render thanks for this assistance to my colleague, Mr. Moyrand, chief traffic superintendent, for his wholehearted collaboration was indispensable to the success of the common undertaking.

I would add that our esteemed chief, Mr. Javary, took a personal interest in the success of this work, the value of which he appreciated fully, and it is with pleasure that I now acknowledge my thanks to him.